JOURNAL OF CLINICAL AND EXPERIMENTAL PSYCHOPATHOLOGY

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VOLUME XIII - NUMBER 2 APRIL - JUNE, 1952

INTERNATIONAL RECORD OF CLINICAL AND RESEARCH PSYCHIATRY

JOURNAL OF CLINICAL AND EXPERIMENTAL PSYCHOPATHOLOGY

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JOURNAL OF CLINICAL AND EXPERIMENTAL PSYCHOPATHOLOGY

Electrocyclic Phenomena and Emotional States*

L. J. Ravitz, M.D.

Thou art not certain,
For thy complexion shifts to strange effects,
After the moon.
SHAKESPEARE: Measure for Measure, Act III, Scene 1.

Man has always pondered the meaning and design of the universe and his relatedness to it. That such design exists is evident. Recently the notion that seemingly unrelated phenomena are integrated by still more basic common denominators was expounded mathematically by Einstein in his Unified Field Theory.[51]

Biological sciences have tended to lag far behind in their approach to the nature of design in living systems, despite the advances in physics during the past few years. H. S. Burr, who was stimulated many years ago by the findings of du Bois-Reymond,[50] Matthews,[59] and Lund,[58] has suggested that living organisms might also consist of charges and field forces responding in an orderly fashion to the same physical laws controlling the inorganic universe. To validate the concept that living systems consist of electrical fields, Burr with the assistance of Lane and Nims perfected a microvoltmeter, by means of which basic electrical properties of living creatures can be studied.[31, 32] Experiments have clearly demonstrated that in all living membranes, tissues, cells, and organisms — from bacteria,[41] invertebrates,[25] and plants[9] to man — there is a relatively steady, stable voltage gradient of considerable

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*Selected portions presented at the 14th annual meeting of the St. Elizabeths Medical Society, Washington, D. C., April 6, 1951, and at the 97th annual meeting of the North Carolina State Medical Society, Section on Neurology and Psychiatry, Pinehurst, N. C., May 9, 1951.

magnitude between any two points, which is altered only by fundamental biological changes in the organism that exists in well-defined patterns characteristic of the species and to some extent characteristic of the individual.[11, 19, 39] Potential differences* between head and tail of chick embryos[28] and *Amblystoma*[29] can be determined even when electrodes are 2 millimeters from the surface. When the sciatic nerve of the frog is stimulated, it produces an electrical field in the surrounding dielectric detectable at a distance of 6 millimeters.[33] PDs have been recorded throughout different devlopmental stages of *Amblystoma*: during early cell division and blastula and gastrula formation, there is a steady rise in PD which accelerates with time and increases until the free-swimming larval stage.[24] A salamander embryo or free-swimming larva revolving between capillary electrode tips as a result of ciliary action causes galvanometer oscillations, the embryo or larva acting as an AC generator of very low frequency. A copper rod with solder on one end produces similar alternating phenomena, whereas a rotating glass rod has no electrical effects.[39] The existence of an electrical pattern in unfertilized frog eggs, which predicts the longitudinal axis of the developing nervous system, has been unequivocally shown,[6] as have significant relationships between electrical patterns of young fruits and the ultimate shape of their gourds.[40] One can predict the subsequent growth history of individual maize[7, 8, 60] and cotton seeds[18] from their mean PDs. Wound-healing in man has electrical correlates similar to that found in other species and of the same nature as is found in growth.[25, 26, 45] DC correlates of sleep[23, 53, 66] and pattern vision[54] have been studied; cyclic variations in trees[10, 15, 16, 20, 67] and mice[20, 21] unrelated to changes in the immediate environment have been recorded; ovulation time can be detected even from finger potentials;[1, 2, 27, 34, 35, 36, 37, 55] malignancy of the female genito-urinary tract is demonstrable by this procedure,[56, 57] which in mice[4, 5, 42, 43, 44] has been differentiated from embryonic tissue;[22] and finally, despite repeated failure to observe electrometric correlations with EEG alterations from trance states, it is possible to determine quantitatively changes in depth of hypnosis by this technic and compare it to DC alterations produced by sodium amytal narcosis, drowsy states, and sleep.[65, 66]

By showing that growth can be slowed, accelerated, or directed by properly applied external sources of potential, Lund's experiments furnish further evidence for the existence of electrical fields and indicate that inherent electrical forces are important factors in polarity and in organization of living systems.[58] These fields which seem to obey physical laws[3, 13, 17, 20, 38, 39, 61, 62] appear to be electrostatic in nature, except that they change slowly with time, and for this reason have been designated as quasielectrostatic.[33]

From this laboratory, preliminary DC studies of psychoses suggest that these disturbed conditions (at least in acute phases) have concomitant electrical correlates — such patients showing considerably higher PDs than a normal control group.[52, 76] However, as no extended study had been made previously on either a normal or abnormal group, with the

*Hereafter referred to as PD.

exception of finger PD studies on both males and females,*[30, 35] the purpose of this investigation was:

1. to determine normal daily DC variations, using head:chest electrode placements and keeping careful records of emotional disturbances and mood fluctuations;

2. to compare the DC pattern of humans with that of trees, local variations in external environment, personality traits, finger potentials, body temperature, blood pressure, pulse, continuous DC records, and EEGs;

3. to formulate a new approach which may provide clues as to the specific physiology involved, if there is any correlation shown in 2.

APPARATUS AND TECHNIC

Detailed descriptions of the Burr-Lane-Nims DC- and AC-operated microvoltmeters can be found elsewhere.[19, 31, 32, 57, 66] In brief, portable vacuum-tube instruments employing, essentially, a Wheatstone bridge circuit, with 10 megohms input impedance, high sensitivity, and high stability, had been developed to measure DC potentials as pure voltage gradients *independent of current and resistance changes.* Reversible, "non-polarizing" Ag-AgCl electrodes[66] immersed in isotonic saline were brought into contact with the subjects who had been saturated with saline at the measuring points with no metal contacting the individuals. Electrode drift, balance, sensitivity and the possibility of air bubbles in the electrodes were constantly checked. Electrodes were reversed at least every third or fourth reading and after each determination if suspect. If there was a discrepancy of more than 2 millivolts, the readings were discarded; otherwise, the last reading was corrected. Occasional electrostatic charges in the surrounding atmosphere were combated by grounding the electrodes to the instrument. In general, it is best not to ground the instruments, as grounds tend to conduct voltage into the machines at unpredictable times.

After experimenting with various electrode placements, it was felt that the most consistent and reproducible results from spot determinations could most easily be effected by summating a bilateral series of 4 PDs between head and anterior chest wall:

Grid electrode		*Ground electrode*
right temporal region	— 1 —	right chest, midclavicular line
right temporal region	— 2 —	left chest
left temporal region	— 3 —	right chest
left temporal region	— 4 —	left chest

Such a combination tends to wash out any errors in single determinations. Two series were taken at each reading and the results averaged. If the summated potentials of the second series differed considerably from the first, a third set was usually taken. Results in millivolts were then tabulated two ways:

*The only obvious correlation was with ovulation. Males were categorized in 3 groups: those with high PDs of 7.0-8.0 millivolts, intermediate, and those with low PDs of 0.2-0.5 millivolts which were usually of positive polarity.

1. Arithmetic summation of absolute voltage gradients without respect to signs.

2. Algebraic summation of voltage gradients with respect to signs, e.g.,

Lead	*1st series*	*2nd series*
1	−5	−5
2	−6	−8
3	+3	+2
4	+3	+3
1. summation of absolute voltage gradients	17	18
2. summation with respect to signs	−5	−8

$Mean_1$ 17.5
$Mean_2$ ..... −6.5

Polarity always refers to the head reading relative to the chest. The apparatus is set up so that needle deflections to the right of the zero point indicate grid electrode positive to ground electrode.

Finger potentials were taken as follows: fingers of the right hand were individually immersed in a beaker of saline containing the grid electrode corresponding to fingers of the left hand dipped in a beaker containing the ground electrode. Thus, sign refers to the right fingers. Averages were then computed. Usually all finger PDs are within 2-3 millivolts of each other. The slightest abrasion, hangnail, or cut usually causes considerable PD increases. Fingers were therefore carefully inspected and injury potentials discarded. In any set of measurements, however, the important factor is relative PD change and not absolute magnitude.

In addition to spot determinations, continuous DC records were taken using a combination Burr-Lane-Nims AC-operated microvoltmeter and General Electric photoelectric recorder.[19, 57, 66] Electrode connections to the instrument and of the instrument to the recorder are arranged so that when the pen is deflected to the right of the zero point, the grid electrode will be positive to the ground electrode by the imposed number of millivolts, and vice versa. Again, it is usually unnecessary to ground the apparatus except in regions where there is considerable electrical interference, especially AC. The recording paper was set at 1 inch per minute.

Using this instrument with only one pair of leads, the most satisfactory placement yielding most significant results was grid electrode anywhere on the forehead and ground electrode on the palm of either hand. No satisfactory results were achieved by bracketing any portion of the cephalic region. At the sensitivity used, one electrode had to be set at some point other than the head. Continuous head:chest readings proved unsatisfactory, for thoracic movements during respiration tend to produce artifacts when an electrode is strapped to the chest. A gauze or elastic band was used to hold the head electrode in place; rubber bands were used for the hand electrode. Saline-soaked pads were placed under each electrode to keep the area moist. To minimize drift, the instrument should be turned on several hours before use. Unlike the chest, the palm is uniformly negative to the head in the waking state.*

*Occasional exceptions are during hypnosis and narcosis.[66]

VARIABLES

The technic described, although relatively simple when mastered, is highly specialized and requires considerable experience before reproducible results are achieved, particularly since the instruments are extremely sensitive and must be handled with considerable care. Differences in electrode pressure, although they produce errors in measurement especially over bony prominences, do not cause significant alterations if care is taken. PD can be changed significantly by temperature variations, although the modification is sufficiently small as to be lost in the results of other variables and can safely be ignored when working in the millivolt range.* Even blood flow changes produce variations which are within standard error of measurement. Only those variables found in the biological activity of the entire system or in the region bracketed by electrodes can alter significantly PD magnitude.[14]

Thus, aside from individual differences in checking readings, there is sufficient theoretical and operational evidence to assume that PDs, as measured by these instruments, represent electrical properties of the organism and not artificially introduced artifacts.

THE EXPERIMENT

Potential differences on ten subjects were measured daily during a period of from 2 — 8 months via DC spot determinations. This group consisted of 7 men and 3 women, 9 of whom were unmarried university students in their twenties. The other subject was a 48-year-old artist. Originally, the group consisted of 6 males, as it was felt that ovulation might cause increases in head:chest determinations which would add to the already confusing array of variables. After 5 months it was thought expedient to add a female group for comparison. Careful notations were made of daily mood fluctuations and experiences by both non-directive and directive procedures. Information concerning life histories of each individual was pieced together from casual conversations. This material was secured through daily contact for a very friendly, congenial, permissive atmosphere was maintained. After several weeks' contact with the subjects, the physician learned to detect more subtle nuances of mood. Sufficient information was obtained by the preceding methods to evaluate each individual including the essentials of his particular emotional problems particularly since most of the subjects were, at one time or another, observed under stress during the course of the experiment. Notation was made of local variations in the external environment, e.g., temperature, barometric pressure, humidity, weather and sunlight.

Toward the end of the experiment, oral temperature, blood pressure, and pulse were concurrently recorded on the original males; finger potentials were taken on 3 males and all of the female subjects; EEGs and continuous DC records were taken on all with the exception of B-15, who left New Haven before an EEG could be arranged. The subjects voluntarily reported daily including Sundays (except C-13), without remuneration, at mutually convenient times which were kept as constant for the individual as circumstances would allow. Within a few weeks, potential measurements became an integral part of their lives.

*Skin temperature differences modify standing potentials in the ratio of 2.5°C./millivolt.[14]

A preliminary study, consisting only of DC spot determinations, was begun on 5 house-officers August 31, 1948, but discontinued after 1 month because of technical difficulties. On October 4 and 5, readings were again started on 2 medical students but soon discontinued for similar reasons.

PRELIMINARY RESULTS

The first 5 subjects* had readings both in the early morning hours and late afternoon or evening (Table I). With the exception of B-2 who was recovering from a mild depression, there was no significant difference between early morning and evening readings, or between readings before and after eating, and for that reason only one daily determination was taken on subsequent subjects. Both A-6 and A-7 were considerably more disturbed than the others, and their means were significantly higher.

RESULTS OF COMPREHENSIVE STUDY

It became increasingly evident in time that minor mood fluctuations could not be correlated with concomitant PD alterations, either as to absolute magnitude or polarity. Twice monthly, at 14-17-day intervals, despite complex individual variations, there appeared in all subjects considerable PD increases which usually accompanied no discernible emotional changes, but which were discovered to occur approximately at the time of the full and new moons. A PD spike sometimes coincided with the exact day of the first and third lunar phases, although more frequently it preceded or followed the lunar day by 24-72 hours. Occasionally, there was a marked PD decrease at one of those times. A double spike preceding and following the lunar day was sometimes encountered. This phenomenon varied among the subjects, and, in order to ascertain further whether it occurred at the same time for all, 5-day running averages of the combined daily means of the original 6 subjects were plotted with and without signs. As can be seen in line 3 of Figs. 1 & 3 and in Fig. 12, the cyclic pattern was not washed out by individual potential variations. In fact, the cyclic pattern is more obvious in graphs plotted with respect to polarity than without. Preliminary records of 1948 were then plotted in a similar fashion; the same cyclic phenomenon was revealed.

Previous studies have indicated, unequivocally, lunar cycles in trees unrelated to any changes in the immediate environment. Likewise, there was no correlation between temperature, humidity, barometric pressure, weather conditions and sunlight in human beings. Stimulated by this discovery of lunar variations in men, Burr decided to plot daily DC measurements on a group of mice he was studying for the electrical characteristics of atypical growth in cancer. Similar cycles were demonstrated. The possibility of recurring instrument artifact has been ruled out by connecting a microvoltmeter to electrodes immersed in a column of saline and taking continuous readings for several months. There was no potential change at any time.

*All were in their twenties with the exception of B-2 who was 33. Only C-4 was married, and she was not living with her husband.

TABLE I

Preliminary study showing differences between a.m. and p.m. monthly means.

Subject	Sex	Characterization	Arithmetic A.M. (millivolts)	Arithmetic P.M. (millivolts)	Arithmetic Combined*	Algebraic A.M. (millivolts)	Algebraic P.M. (millivolts)	Algebraic Combined*
		September, 1948 means						
C-1	m	Energetic; egocentric; active; aggressive; independent; ambitious; crafty; successful in work.	12.6	11.9	11.9	−4.4	+0.1	−2.4
B-2	f	Quiet and superficially colorless, although active, aggressive and independent; competent; sensitive; recovering from mild depression; ambitious; fairly successful in work.	9.9	16.6	13.5	−2.0	−13.1	−7.4
C-3	m	Cyclothymic; verbose; strong passive-dependent social and sexual needs partially compensated by intellectual aggression; slightly effeminate; ambitious; successful in work.	13.0	13.0	12.4	+4.8	+1.6	+2.9
C-4	f	Active; aggressive; independent; beguiling; tremendous ambitions and drive for power; successful in work.	10.8	11.1	10.9	−1.5	−2.8	−1.4
C-5	m	Energetic; excitable; hedonistic; somewhat effeminate; actively seeks friends to become extremely dependent on them; occasionally partially compensatory aggressive sexual desires although often passive sexually; not ambitious; fairly independent and successful in work despite occasional tenseness and anxiety which at times becomes sufficiently great to interfere.	10.9	7.9	11.0	−1.6	−0.9	−1.9
		October, 1948 means						
A-6	f	High-strung; temperamental; hypersensitive; active, aggressive, independent; frustrated; occasionally hostile, impulsive and disorganized; strong needs for achievement; extremely ambitious; successful in work.	23.0	—	—	−17.0	—	—
A-7	m	Unobtrusive; shy; hypersensitive; occasionally withdrawn; strong passive-dependent social and sexual needs; not particularly ambitious; successful in work.	19.8	—	—	+4.1	—	—

*Occasionally, due to pressure of time, only 1 daily reading was taken. Combined means, therefore, do not necessarily represent an average of the total a.m. and p.m. means, but a summation of all daily averages divided by the total number of days.

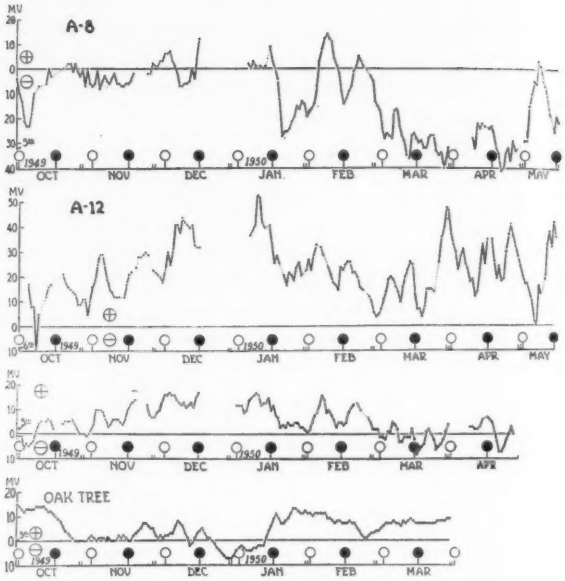


FIG. 1. Algebraic five day running averages of mean daily PDs during different moon phases.

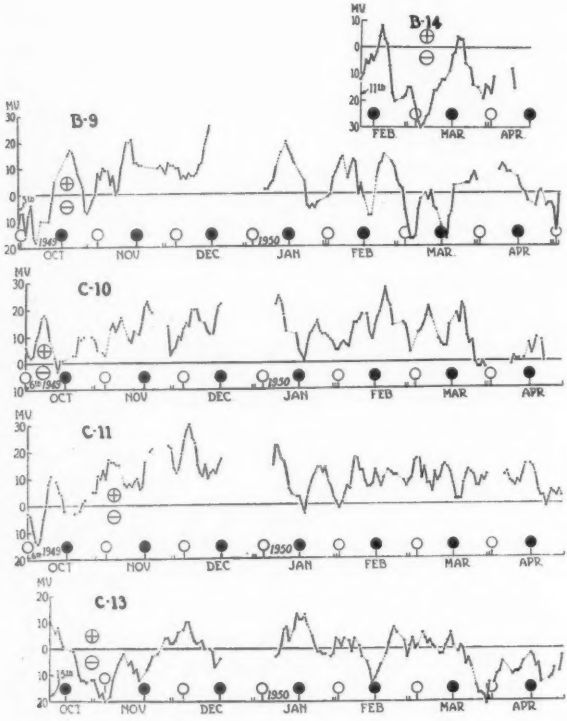


FIG. 2. Algebraic five day running averages of mean daily PDs during different moon phases.

Finger potentials did not reveal these cycles but remained relatively constant for a given individual, except in women at ovulation time. Increased finger PDs due to ovulation always accompanied significant PD increases with head:chest readings, although the magnitude of the latter was often greater at other times, as can be seen in Fig. 10: B-15, 16 & 17 (presumed ovulation time indicated by arrows). Yet head:chest readings of considerable magnitude were not usually associated with increased finger PDs (Fig. 7). There was no alteration in either head:chest readings or finger potentials during menstruation unless ovulation occurred at this time.

Figures 1-5 illustrate 5-day running averages of all subjects, with and without signs. Individuals with generally consistent positive polarity show almost identical cycles; those whose PDs were mostly negative have cycles which at corresponding times are mirror images of each other; others whose polarity was almost constantly in a state of flux show considerable variation. No discernible correlation was detected between temperature, blood-pressure, pulse, and PDs (Table II and Fig. 6).

SUBJECTS

For purposes of exposition, all subjects were placed arbitrarily in 3 groups without regard to DC or EEG results:

A. *The severely maladjusted* — individuals who, because of conflict with strong unconscious drives, frequently behaved in an irrational fashion and could not usually make satisfactory working, interpersonal, or sexual adjustments at the time.

B. *The moderately maladjusted* — individuals who, although in conflict a good deal of the time, had much better insight into their problems, usually behaved in a less irrational fashion, and tended to make better working, interpersonal, or sexual adjustments.

TABLE II

Average monthly temperature, blood pressure, and pulse for 7 subjects

Subject	Time	Temperature°F*			Blood Pressure				Pulse			
		Feb.	*Mar.*	*Apr.*	*Feb.*	*Mar.*	*Apr.*	*May*	*Feb.*	*Mar.*	*Apr.*	*May*
A-8	5:30 p.m.	98.3	98.4	98.1	128/63	128/62	133/67	129/63	64	65	65	65 irre.
A-12	5:45 p.m.	98.7	98.9	98.9	114/81	110/78	108/77	—	77	78	77	—
B-14	7:45 p.m.	98.1	98.0	—	118/78	117/73	—	—	75	74	—	—
B-9	5.35 p.m.	99.1	99.4	99.2	150/76	143/83	138/85	—	89	92	86	—
C-10	11:40 a.m.	97.3	97.4	97.5	111/85	108/85	107/85	—	82	84	82	—
C-11	11:50 a.m.	98.9	98.7	98.6	115/76	112/77	110/78	—	74	75	75	—
C-13	11:15 a.m.	98.8	99.1	99.0	126/79	124/78	123/80	—	74	75	75	—

*After trying a variety of thermometers, it was concluded that accurate results could only be obtained if the thermometer was left in for at least 10 minutes. In many instances, temperature rose a full degree between 5 and 10 minutes. No temperature was taken on female subjects for no correlation had been found between PDs in males and temperature or between temperature and ovulation spikes in previous studies.[2]

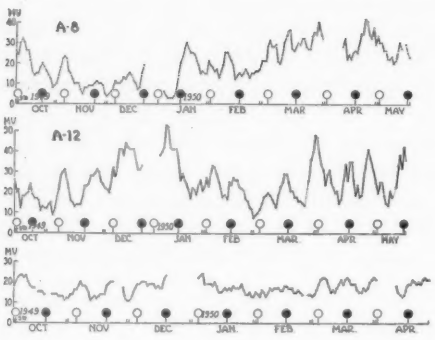


FIG. 3

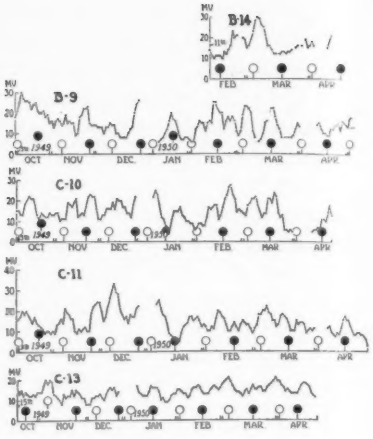


FIG. 4

FIG. 3. Arithmetic five day running averages of mean daily PDs during different moon phases.
FIG. 4. Arithmetic five day running averages of mean daily PDs during different moon phases.

C. *The reasonably well-adjusted* — individuals who, despite any marked psychologic deviations, had considerable insight into personal problems, tended to make a good adjustment at the time, even though such adjustment might be achieved only in the restricted milieu of a secure social group, and generally behaved in a more rational fashion.

This classification does not imply that those in group C were more normal or necessarily more stable than the ones in group A. An emotionally-labile individual, whose behavior deviated widely from what is generally accepted as normal, might be placed in the C division if he was aware of what he was doing, the significance and consequences of his acts, and, although he might break under stress, was reasonably contented and geting along fairly well in the society in which he found himself, in contrast to a possibly more conventional or normal-appearing individual, who would be placed in the first category if he was in almost constant turmoil about unconscious drives and tendencies, and for this reason tended to behave irrationally much of the time. For example, one of the subjects (including the preliminary subjects), classified as C, was a reasonably adjusted homosexual; whereas, two subjects in the A group were desperately trying to make a heterosexual "adjustment" devoid of sexual relations. Another subject who, despite a pleasing personality was not generally attractive to girls, dated exclusively and seriously considered marriage with almost every girl friend, who showed him any affection, in order to appear masculine (avoiding strong well-rationalized homosexual drives) and to escape from his infantilizing family.

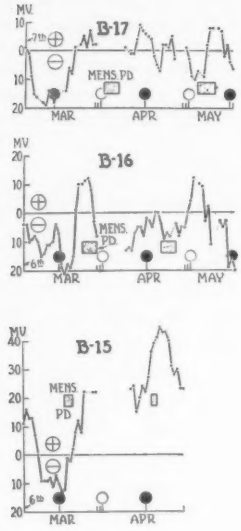
A-8 is an energetic athletic male student in the sciences; marked emotional and vasomotor instability; impulsive; self-centered; adaptable; very sentimental and sensitive; anxious, tense, confused and disorganized under stress, at which times he indulges in diffuse physical activity, blocks, stutters, and

tends to read in reverse order; infantilized by family to whom he reacts with dependence and submissiveness; retreats from effort and responsibility; great difficulty urinating in presence of males; idealizes men; conflicts center about strong partially-compensated passive-dependent social and sexual needs; frequent headaches and almost incapacitating gastric symptoms of neurotic nature; inhibited, guilt-ridden, and self-punitive; judgment poor re work and love-objects; dependent upon irrational emotional attachments antithetical to family's ideals; unambitious; unsuccessful and unorganized in work; no goals.

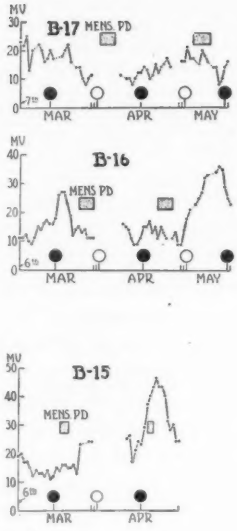
Subject A-8, who was undergoing psychiatric treatment, showed considerable fluctuation as regards polarity from October-December, 1949, although 14-17-day cycles are evident on his graph plotted as absolute voltage gradient during this period (Figs. 1 & 3). In January, A-8's head tended to become increasingly negative to his chest. At this time, he was under pressure studying for midyear examinations. Toward the end of February until readings were stopped, the subject was having considerable conflict regarding highly emotional interpersonal relationships. This occurred concomitantly with increased negativity (a gradual rise in absolute PD). Throughout this time, A-8 did poorly in his work which he tended to neglect, although his working habits and ability to concentrate improved considerably when satisfactory emotional outlets became available after March, despite increased conflict concerning these situations. High isolated positive or negative PDs were often associated with diffuse hyperactivity, tenseness, facetiousness, and general emotional lability. No discernible correlation exists between temperature, blood-pressure, pulse, and PD, although there appeared to be a slight tendency for increased pulse rate and pulse pressure to be associated with increased positivity of PD (Fig. 6). Exercise, however, did not change A-8's potentials significantly. His pulse was usually quite slow, having irregular dropped beats particularly at rates under 60, which tended to disappear when rate exceeded 70. A summary of temperature, blood-pressure, pulse, continuous DC tracing, and EEG will be found in Table III.

A-12 is a rigid, perfectionistic, compulsive male student in the sciences; very shy and hypersensitive, emotionally-isolated, introverted and autistic; at times insecure, suspicious, withdrawn, and apathetic; active, independent, and driving re work; passive sexually and in social relations with others; not impulsive; no overt guilt; anxious, tense and impatient under stress; conflicts relate to inhibitions and occasional hostile, aggressive impulses; somewhat hypochondriacal; strong needs for achievement; ambitious; successful and methodical in work; reasonably well-defined goals.

Subject A-12 showed a regular cyclic rhythm which was almost entirely positive, although isolated negative PDs occurred (Figs. 1 & 3). A definite correlation was found between mood and PD: apathy, pent-up hostility, aggressiveness, irritability, insecurity, and general withdrawal from people usually coincided with summated PDs exceeding +40 millivolts. Conversely, enthusiasm, conviviality, general amiability, and the subjective feeling of well-being were almost uniformly associated with low positive or negative readings. Daily fluctuations were seldom obvious to the subject but were noted by others. It is of interest that A-12's PD gradually increased from October through the first part of January and was associated



Algebraic



Arithmetic

FIG. 5

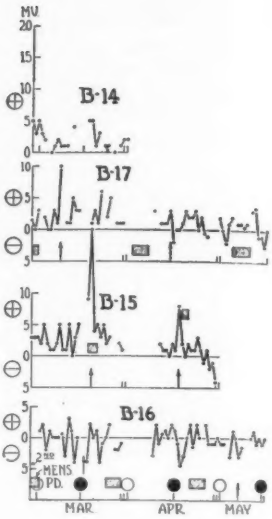


FIG. 7

FIG. 5. Algebraic and arithmetic five day running averages of mean daily PDs for 3 females showing menstrual periods and lunar phases.

FIG. 7. Algebraic finger potential plots for 1 male and 3 females, showing presumed ovulation time (indicated by arrows) and menstrual periods.

with increasing insecurity, withdrawal, autistic thinking, and suspiciousness. This sustained mood was consciously felt by the subject, as was his general improvement during February and March. At this time, which coincided with considerably lower PDs, subject said that he felt less sensitive to other people and enjoyed being with others much more. He felt less insecure. Mathematical calculations, which occupied much of his daily work, tended to go more smoothly, and he appeared more sociable and less introspective and isolated. On many occasions he sang and evidenced a dry but keen sense of humor. PDs taken before, during, and immediately following a vigorous rubdown remained unaltered. His best moods generally were accompanied by readings below +12 millivolts — also rare readings when his head became negative to his chest (his highest negative reading: —19.5 millivolts, May 3, 1950).

B-17 is an emotionally-labile, moody female student in the social sciences; flighty; impatient, demanding, active, independent, aggressive, and driving; remarkably adaptable and malleable; hypersensitive; reacts to stresses in an anxious, tense, impulsive, irrational, disorganized and hostile fashion; aggression and hostility often inhibited; conflicts relate to frustrations concerning poorly-defined goals and emotional attachments; strong needs for achievement; ambitious; unsuccessful and unorganized in work.

Despite almost constant emotional turmoil and frustrations during the relatively brief period subject was measured, B-17 did not show consistent voltage increases, although her cyclic pattern was irregular (Fig. 5). Probably due to skipped days, the exact ovulation time of B-17 was unequivocally determined only in March — 7 days following her period (Figs. 7 & 10).

B-15 is an emotionally-labile, friendly female student in the social sciences; adaptable; hypersensitive; strong maternal drives; tends to depend on others; reacts to stresses with considerable anxiety, impulsiveness, and poor judgment; drifts from one thing to another; conflicts relate to poorly-defined goals, dependent needs, and emotional attachments; unambitious; unsuccessful and unorganized in work.

Subject B-15, in contrast to B-17, showed a fairly regular cyclic pattern (Fig. 5). In April, there was considerable conflict regarding her decision to leave school and obtain employment. During this transition period, it was necessary to find both a job and new living quarters. Concomitant conflict over emotional attachments existed. PDs at this time

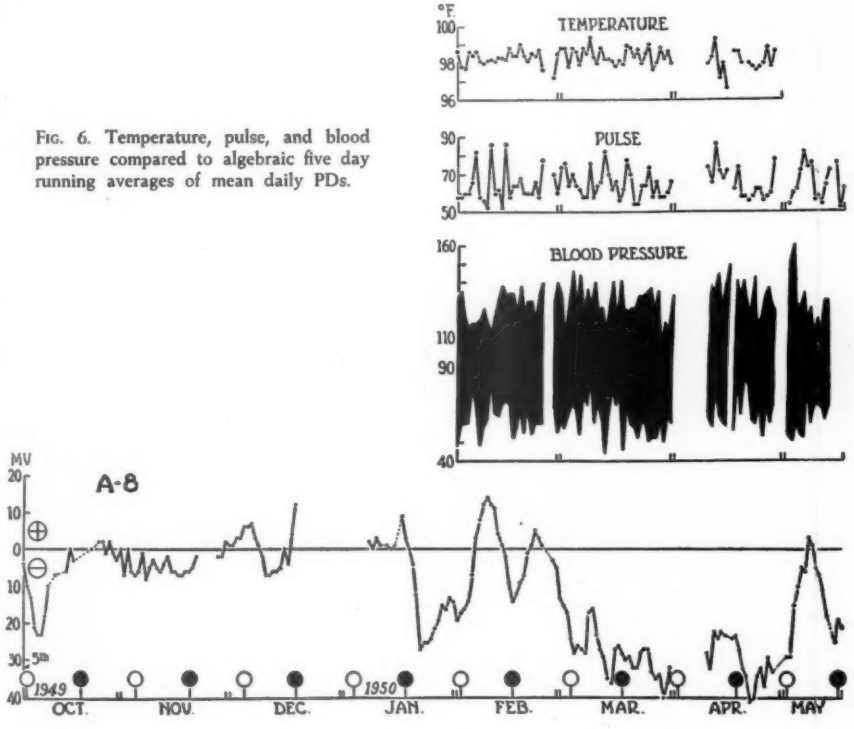


FIG. 6. Temperature, pulse, and blood pressure compared to algebraic five day running averages of mean daily PDs.

TABLE III

Characterization, monthly means with and without signs, monthly ranges, mean temperature, blood pressure, pulse, quality of DC cycles, continuous DC tracings and EEGs for 10 subjects.

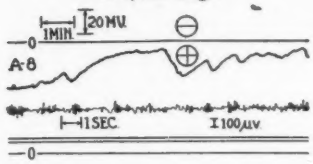
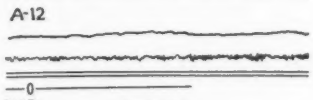
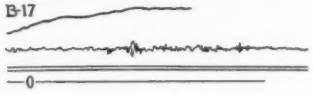
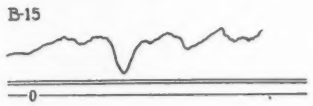
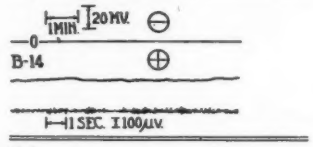
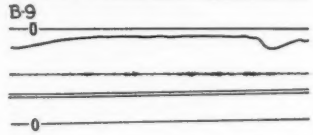
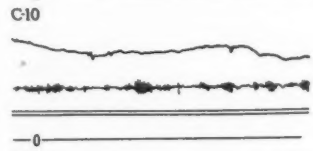
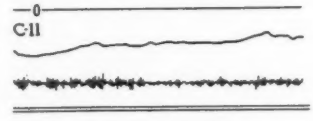
Subject	*Sex*	*Characterization*	*Algebraic Monthly Means* (with signs)									
			1949 *Oct.*	*Nov.*	*Dec.*	1950 *Jan.*	*Feb.*	*March*	*April*	*May*		*Average Means*
A-8	m	Energetic; tense and disorganized under stress; passive-dependent needs; guilt-ridden and self-punitive; unambitious.	− 6.2	− 4.4	+ 2.7	− 8.2	− 2.1	− 28.7	− 29.8	− 10.8	.....	− 10.9
A-12	m	Perfectionistic; isolated; independent re work; passive in relations with others; ambitious.	+ 13.3	+ 20.2	+ 34.9	+ 30.4	+ 21.0	+ 19.6	+ 25.4	+ 21.6	.....	+ 23.3
B-17	f	Flighty; impatient; demanding; aggressive; hostile, irrational and impulsive under stress; ambitious.	——	——	——	——	——	− 5.3	+ 1.8	− 2.0	.....	− 1.8
B-15	f	Flighty; strong maternal drives; impulsive and anxious under stress; unambitious.	——	——	——	——	——	+ 4.3	+ 30.8	——	.....	+ 17.6
B-16	f	Independent; aggressive; strong social consciousness; anxious under stress; ambitious.	——	—	——	——	——	− 7.5	− 5.7	− 4.3	.....	− 5.8
B-14	m	Moody; hedonistic; rational under stress; passive-dependent needs; ambitious.	——	—	——	——	− 8.5	− 14.1	——	——	.....	− 11.3
B-9	m	Tense; anxious; rigid; independent; self-righteous; isolated; excess anxiety and tenseness under stress; moderately ambitious.	− 3.3	+ 9.9	+ 13.2	+ 4.7	+ 6.4	− 3.9	+ 0.3	——	.....	+ 3.9
C-10	m	Excitable; hedonistic; impulsive; tense under stress; passive-dependent needs although intellectually aggressive; not markedly ambitious.	+ 7.7	+ 11.4	+ 15.3	+ 12.1	+ 14.6	+ 8.3	+ 3.1	——	.....	+ 10.4
C-11	m	Reserved; plodding; perfectionistic; sometimes unduly upset under minor stress; passive-dependent needs; relatively isolated; inhibited; ambitious.	− 0.7	+ 12.9	+ 17.8	+ 9.0	+ 9.5	+ 10.1	+ 6.3	——	.....	+ 9.3
C-13	m	Perfectionistic; isolated; ration-	− 0.4	− 7.6	+ 2.2	+ 2.2	− 1.8	− 3.6	− 6.2	——	.....	− 2.2

lated; inhibited; ambitious.

C-13	m	Perfectionistic; isolated; rational under minor stress; intellectually independent although dependent in working relationships; no longer ambitious.	— 0.4	— 7.6	+ 2.2	+ 2.2	— 1.8	— 3.6	— 6.2	——	.....	— 2.2										

Arithmetic Monthly Means: (without signs)										*Monthly Ranges*										*Mean*			
1949 Oct.	Nov.	Dec.	1950 Jan.	Feb.	March	April	May		*Average Means*	1949 Oct.	Nov.	Dec.	1950 Jan.	Feb.	Mar.	Apr.	May	*Average Ranges*	Temp. °F.	B.P.	Pulse
18.0	11.0	13.1	15.0	17.1	29.8	30.4	23.4	.....	19.7	51.8	59.0	58.0	79.0	60.2	68.5	60.5	54.5	61.4	98.3	130/64	65
18.2	21.6	35.4	30.7	21.8	23.1	26.2	25.9	.....	25.4	77.3	46.2	60.8	61.5	45.5	86.0	58.0	78.5	64.2	98.8	111/79	77
—	—	—	——	——	17.3	12.4	15.4	.....	15.0	—	—	—	—	—	66.5	42.5	76.0	61.7	—	———	—
—	—	—	——	——	16.3	31.4	——	.....	23.9	—	—	—	—	—	84.8	47.5	——	66.2	—	———	—
—	—	—	——	——	14.9	12.0	26.0	.....	17.6	—	—	—	—	—	85.0	52.2	92.5	76.6	—	———	—
—	—	—	——	14.7	17.4	——	——	.....	16.1	—	—	—	—	69.5	55.0	——	——	62.3	98.1	118/76	75
20.3	14.2	15.0	9.5	15.9	14.6	11.8	——	.....	14.5	60.0	62.3	36.0	42.2	89.5	72.5	49.0	——	58.8	99.2	144/81	89
14.6	16.1	17.1	13.3	16.1	13.8	11.9	——	.....	14.7	43.5	65.7	49.3	45.5	40.0	58.0	37.0	——	48.4	97.4	109/85	83
13.7	15.4	20.8	13.9	12.6	14.2	8.6	——	.....	14.2	41.3	46.0	43.7	48.5	36.2	51.0	34.0	——	43.0	98.7	112/77	75
14.0	12.8	13.1	13.4	14.7	16.2	13.9	——	.....	14.0	47.6	35.3	37.0	45.5	43.5	50.0	32.5	——	41.5	99.0	124/78	75

*The first number in the classification represents the same general code suggested by P. A. Davis[48] dividing EEG patterns into 5 categories: 1. perfectly normal; 2. normal; 3. borderline; 4. abnormal; and 5. diagnostically abnormal. The second one or more letters used to designate the most dominant or important organization of frequencies in the tracing. *A* is used for the relatively pure dominant alpha type of record. *MF* signifies repose rhythm mixed with fast activity. *MS* signifies repose rhythm mixed with slow activity as a secondary feature. *M* is a mixed pattern in which repose, fast, and slow waves are present. *F* signifies dominant fast activity and is equivalent to what Pauline Davis described as the *B* type of record. *S* signifies a slow pattern either at the slowest end of the normal alpha frequency (8-8.5/sec.) or slower. *DD* stands for diffuse dysrhythmia; *LD* for local dysrhythmia. *Fint* signifies fast interference, and *Sint* stands for slow interference. *VDC* is used for high voltage episodes of irregular organization. *Pet-Mal* signifies the spike and dome discharge of petit-mal; *PMV* stands for the slow spike and wave discharge or petit-mal variant; *GM* for the high voltage fast activity usually seen in grand-mal; *PM* stands for psychomotor electrical discharge; *LL* signifies localized disturbance and is used particularly for a spike or delta focus as is seen in a local brain lesion, but not primarily a convulsive disorder; and *GD* is used for gross dysrhythmia. Subscript letters of *d*, *e*, and *l* may be used after the capital letters to describe diffuse, episodic, or local characteristics to the organization. The letters *H* and *J* can be used in conjunction with any of the above letters to represent asymmetry: *H* suggests difference between hemispheres; *J* suggests difference between lobes on one side (e.g., greater alpha activity in motor than occipital regions). Finally, two subscript numbers are used. The first designates the maximum voltage persistent for 3 consecutive waves of any of the frequencies seen in the entire pattern: 2 represents voltages over 75 μV; 1, voltages between 35 and 75; and 0, voltages under 35 μV. The second subscript number signifies the quantity of alpha or alpha index from the left occipital region: 2 is from 67-100% alpha; 1 is from 33-66% alpha; and 0 represents under 33%. This descriptive system, devised in 1945, is essentially the use of Pauline Davis' system with additional subgroups and subscripts. It is designed fundamentally with the idea of being able to pull out of the file all records which look alike and will be published in detail.[49]

Quality of DC Cycles	*Continuous DC Tracings and Occipital EEGs*	*EEG Ratings**
Irregular; marked differences between results plotted with and without signs through February; graphs from March through May are mirror images of each other due to consistent negative readings.		$3MS_{22}$
Regular; graphs plotted with and without signs almost identical due to predominance of positive readings.		$2MF_{12}$
Irregular; graphs plotted with and without signs dissimilar due to mixed positive and negative readings.		$4DD_{20}$
Regular; results plotted with and without signs similar although not identical.		——
Irregular; results plotted with and without signs dissimilar due to mixed positive and negative readings.		$3M_{10}$
Regular; results plotted with and without signs almost mirror images of each other due to predominance of negative readings.		$2A_{12}$
Generally regular; results plotted with and without signs dissimilar due to mixed positive and negative readings.		$2F_{00}$
Regular; graphs with and without signs almost identical due to predominance of positive readings.		$3MS_{22}$
Regular; graphs with and without signs identical except first half of October when they are mirror images of each other because of negative values. 14-17-day cycles tend to break-up into 7-9-day cycles after February, 1950.		$3M_{22}$
Regular; voltage fluctuations less than others; graphs with and without signs dissimilar due to mixed positive and negative readings; results plotted with signs also suggest 6-week cycles.		$2A_{12}$

*Refer to footnote on page 83.

became increasingly positive — jumping from 16.3 millivolts in March to 31.4 millivolts in April (without signs), and from +4.3 to +30.8 (with signs — Table III). Ovulation during March was on the second day of her menstrual period, in April one day before her period (Figs. 7 & 10). B-15's highest daily average (+59.5 millivolts, March 27, 1950) occurred when she felt most distraught following a quarrel with her boy friend. Despite her relatively low daily readings for 5 days, she correctly predicted a high PD. However, finger PDs this date averaged only +3 millivolts.

B-16 is a dynamic female student in the social sciences; active, independent and aggressive; strong masculine trends; adaptable; very sensitive; strong social consciousness; not impulsive; reacts to stresses in fairly rational fashion but with considerable anxiety; conflicts relate to poorly-defined goals, dependent wishes, and emotional attachments; ambitious; successful in work.

A regular cyclic pattern was present (Fig. 5). Conflicts regarding personal problems and transition periods were most marked during May. At this time, subject had a mixture of both high negative and high positive PDs; B-16 was the only subject who exhibited this mixed polarity of high values. Consequently, while her absolute voltage gradient increased from 12.0 millivolts in April to 26.0 millivolts in May, her algebraic mean remained low and even decreased slightly (—5.7 to —4.3 millivolts) during this period (Table III). As far as can be determined, subject ovulated only during March and May at the middle of her cycle. This was associated with episodic RLQ pains (*Mittelschmerz*), although finger PDs were lower than what is usually obtained, which might be due to the fact that only one daily reading was obtained (Fig. 7). Head:chest readings, however, were high on both occasions (Fig. 10).

B-14 is an unstable, moody male student in the arts; introspective; egocentric and hedonistic; somewhat effeminate; adaptable; hypersensitive, although relatively insensitive to feelings of others; difficult to get along with; not impulsive; very little overt anxiety or guilt; reacts to stresses in fairly rational fashion; at times suspicious, preoccupied and withdrawn; passive in relationships with others, although cannot be pushed around; conflicts relate to strong passive-dependent social and sexual needs vs. independent strivings; intellectually active; ambitious; successful in work; well-defined goals.

Subject B-14 volunteered for the experiment in February due to interest in his own marked mood swings. His head was almost uniformly negative to his chest (*cf.* A-8). For the 2 months readings were taken, there was a uniform, predictable cyclic pattern (Figs. 2 & 4). Increased negativity of PDs exceeding —15 millivolts was associated with sullenness, general irritability, hypersensitivity, preoccupation, and, to some extent, withdrawal from people and all social activities, although this was never as sustained as that of A-12. Emotional conflicts concerning passivity in interpersonal relationships were always present in varying degrees. Subject felt best when readings of increasing positivity were obtained. During February and March, such positive voltage shifts occurred shortly following the new moon; periods of greatest negativity approximated the full moon (Fig. 2). PD decreases and increases at this time followed a pattern very similar to that of A-8 during

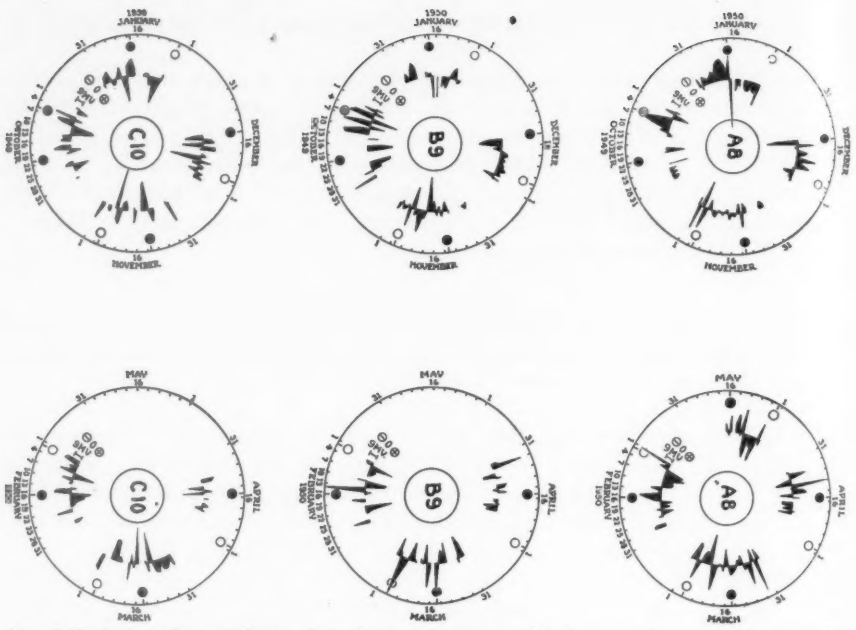


Fig. 8.Algebraic polar coordinate plots showing deviations of daily mean from monthly mean PD during different lunar phases for eight months.
[Circle with 3 lines indicates lunar eclipse.]

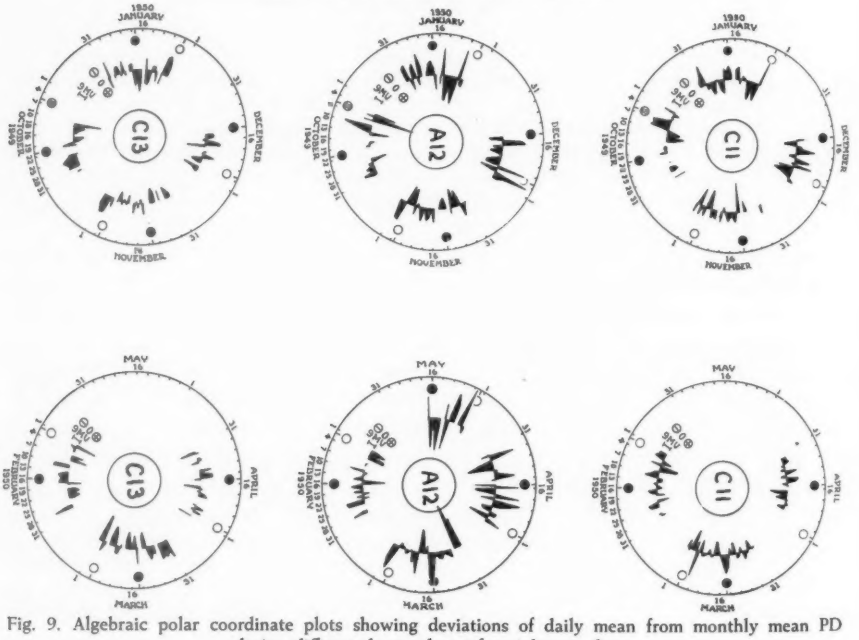


Fig. 9. Algebraic polar coordinate plots showing deviations of daily mean from monthly mean PD during different lunar phases for eight months.

the corresponding time; both had basically very similar conflicts, which in these two instances correlated with PDs of considerable negativity.

B-9 is a tense, anxious, rigid, compulsive male student in the sciences; active and independent; puritanical and self-righteous; insensitive to others, emotionally-isolated; reacts to stresses with excess anxiety and tenseness — rigidity often preventing rational behavior; not impulsive; moderately ambitious; successful in work; well-defined goals.

Subject B-9 showed a somewhat irregular pattern, although a definite cyclic rhythm was present (Figs. 2 & 4). He was usually tense, and, although significant mood swings rarely could be detected, low positive or negative readings were usually associated with a generally less tense appearance. At no time was there evidence of any specific emotional conflict, other than jealousy of his more popular roommate. Because of a tendency toward hypertension, B-9's physician prescribed a phenobarbital mixture on April 10, which did not affect either BP or PD appreciably. During the period of the new moon, there was a tendency for B-9 to develop a high circumscribed potential focus on his right or left temporal region, which would occasionally shift to the opposite side within a few hours and could not be attributed to abrasions, blackheads, cuts, or dermititis of any kind. If the grid electrode was moved only a few millimeters from this spot, the PD would drop precipitously — sometimes as much as 20 millivolts. This phenomenon was less apparent in the other subjects.

C-10 is an emotionally-labile, voluble, excitable male student in the arts; egocentric and hedonistic; impulsive; adaptable; somewhat effeminate; very sensitive, although relatively insensitive to feelings of others; creative imagination; no guilt; reacts to stresses in rational fashion but with frequent tenseness and confusion; passive in relationships with others; strong passive-dependent social and sexual needs, although intellectually aggressive; relatively free from conflicts; not markedly ambitious; tends to be unsuccessful in routine work.

Cyclic variations in this subject were regular (Figs. 2 & 4); PD spikes were generally predictable within 2 or 3 days (Fig. 8). C-10 tended to feel more energetic, tense, and generally keyed-up when his PD was of greatest magnitude. At such times, his working capacity seemed to increase. He was on thyroid medication supposedly for a somewhat subnormal BMR.

C-11 is a steady, reserved, plodding, perfectionistic male student in the arts; introverted; rigid at times, although adaptable within limits; not impulsive; hypersensitive; reacts to minor stresses in rational fashion, although sometimes becomes unduly upset; very little overt anxiety, guilt or serious conflicts; passive in relationships with others; strong passive-dependent social and sexual needs which tend to be masked by relative emotional isolation, inhibition, and phlegmatic attitude; ambitious; fairly successful in work.

Records of C-11 are remarkably similar to those of C-10 (Figs. 2 & 4). During December, C-11 tended to be unhappy and slightly irritable. From February until the experiment ended, his mood improved considerably, and he felt more relaxed and contented for a

longer duration than at any other time since October, 1949. This was associated with lower PDs and a tendency for 7-9-day cycles to appear.

C-13 is a pleasant stable male in the arts; married 20 years; rigid, perfectionistic, and compulsive; sensitive; friendly, but emotionally-isolated; mood normal; creative imagination; reacts to minor stresses in rational fashion; intellectually independent, although dependent in working relationships; somewhat hypochondriacal; relatively free from anxiety, guilt, and serious conflicts; no longer ambitious; successful in work.

Changes in polarity occurred frequently as is evidenced by the graphs; with signs (Fig. 2), there appear to be 6-week cycles in addition to 2-week cycles — the latter being most evident when absolute voltage gradients were plotted (Fig. 4). Voltage fluctuations were minimal as compared to other subjects. This may be attributed to the fact that the others were considerably younger, for it is known that younger trees and mice tend to show much wider swings relative to older ones.[16, 17] In all subjects, unusually vivid dreams often occurred the night preceding or following high potential readings.

Polar coordinate graphs (Figs. 8-11) show PD deviations, with signs, of the daily mean from the monthly mean to compare not only fluctuations in the same individual at different times, but between different subjects at the same time as contrasted to trees. In October, no records were taken at the dark of the moon.

C-10 showed most prominent spikes 1-4 days after the full moon and approximating the new moon (Fig. 8). Those spikes seldom coincided with the exact lunar day and varied somewhat in the same individual from month to month. During December, the deviations of all subjects tended to approach the deviations of the trees which always showed more stability and less voltage fluctuations than did the subjects. In January, A-8 was almost a mirror image of the trees, showing positive deviations during the first half of the month, followed by positive and negative spikes ($+45.5$ and -33.5 millivolts) coinciding with the new moon, and negative deviations during the remainder of the month (Figs. 8 & 11). Had the tree electrodes been reversed, an identical picture would have been produced. During March, there was considerably greater scattering in both trees and subjects; voltage fluctuations were minimal in April. Although on first inspection they appear dissimilar, A-8 and A-12 both produced similar configurations during May, being mirror images of each other. It should be remembered that these graphs illustrate only *relative* values. During the first part of May, PDs of A-12 were of reduced positive values (Fig. 9); those of A-8 of reduced negative values, i.e., both tended to approach zero. Thus, the graph of A-12 appears as a negative deviation during this time and that of A-8 as a positive deflection. At the period of the new moon, PDs in both began to increase — positively in A-12 and negatively in A-8. Deviations of considerable magnitude were often followed by marked deviations in the opposite direction, e.g., B-14 and B-16 (Fig. 10).

In most subjects, there was a gradual persistent positive PD increase from October through the middle of January. This can be seen clearly in the smoothed graphs (Fig. 13)

as can the general decrease from January until May, and again, a beginning increase at that time. In some subjects, there was a complete reversal of polarity. Serious emotional disturbances were present in A-8 and A-12 where greatest deviations from the baseline exist, i.e., November-December in A-12 and March-May in A-8. PD spikes of A-8 and B-9 became entirely negative from February-May. In the others, positive lunar spikes were of lesser magnitude during the spring.

The oak tree was almost a mirror image of the subjects; its polarity being determined

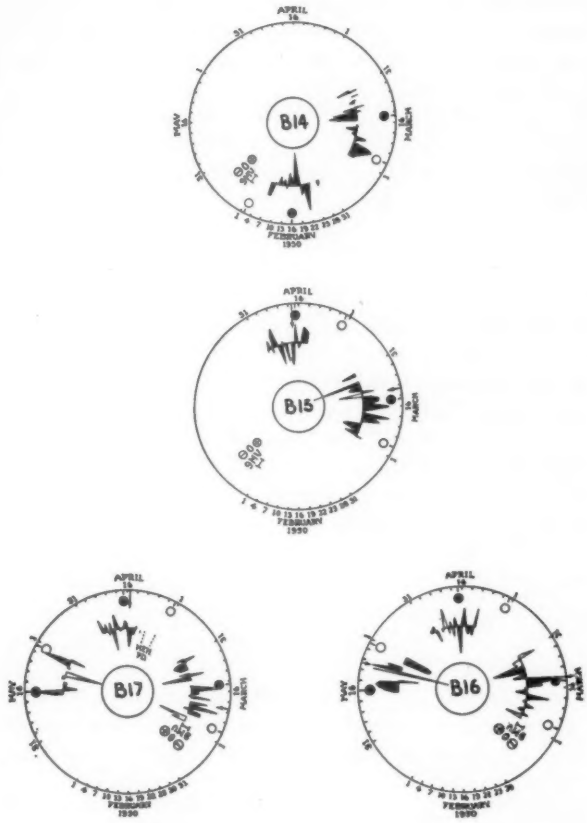


Fig. 10. Algebraic polar coordinate plots showing deviations of daily mean from monthly mean PD for 1 male and 3 females, presumed ovulation time (indicated by arrows), and menstrual periods (unshaded portions).

only by the fact that the grid electrode is placed 5 feet above the ground electrode.* Tree records of previous years revealed a closer direct correlation to human records for 1949-1950 — a tendency for potentials to increase in the fall and early winter and to decrease in late winter and early spring — the polarity of the upper electrode relative to the lower electrode eventually reversing until a low point was reached about the first of May.[16, 20]

Although subjects were classified independently of electrometric studies, the A group showed significantly higher PDs than the B and C groups (the C group showing the lowest), when these were plotted without respect to signs. With signs, the B and C groups tended to merge, although the A group maintained the highest positive and negative PDs. A seeming exception is B-14, who had the most negative total mean. However, as he was plotted only over a 2-month period, his high negative average is not comparable to that of A-8, who was not only measured for 7½ months, but was running considerably more negative readings at the same time (Table III).

Monthly range is also indicated in Table III (the difference between the highest positive and highest negative daily means for the month). Although there was some tendency for emotional disturbances to correlate directly with increased ranges, this was not invariably true. However, the C group again showed the lowest ranges; the A and B groups tending to merge.

DISCUSSION

The studies of R. S. Turner in 1936 on 6 psychotics and 10 students indicated that, with one exception, normal controls uniformly had heads positive to chest or occasionally slightly negative; high negative determinations were present in psychotics. The one control student with high negative readings became psychotic the following year. As electrode placement differed from that used in the present study, values are not comparable, although high negative readings of A-8 and to a lesser degree of B-14, also high positive readings of A-12 and B-15, all accompanied considerable conflicts and maladjustments of varying degrees. Periods of emotional instability were often associated with extreme lability of the readings.

From the values in Table III, one might consider the normal monthly mean as roughly lying somewhere between —7 and +18 millivolts, or when plotted as absolute voltage gradients, between 8 and 18 millivolts. Any consistently sustained values exceeding this in either direction seem pathognomonic of psychic disturbance.† The highest daily means were —70.5 (A-8) and +69.5 millivolts (A-12). Despite previous difficulties with technic, the monthly means of the preliminary determinations (Table I) approximated the averages of the present study. Although the exact significance of polarity is yet to be explained,

*Oak, elm, or maple trees have been recorded continuously in Old Lyme or New Haven, Connecticut, since 1943, with weatherproof electrodes permanently embedded in the cambium.

†This was confirmed by later studies at Duke University and the Veterans Administration Hospital of Roanoke, Virginia, which showed that DC voltages of psychotics are considerably higher than those obtained on normal individuals.[68]

cyclic variations appeared more prominent when plotted with respect to signs. Negative PDs (including negative lunar spikes) were encountered much more frequently in all subjects during late winter and early spring — the head electrode becoming increasingly negative to the chest electrode. Some subjects showed a complete reversal of polarity at this time. Even though such seasonal variations in trees and humans are not directly related to altered temperatures, there may exist a correlation with mean temperatures, as they possibly influence the general level of the living process. It is hoped that all subjects participating in this experiment can be followed and periodically checked in regard to their adjustment for emotional disturbances accompanying generally sustained high negative or positive readings exceeding -15 or $+25$ millivolts may be potentially malignant.

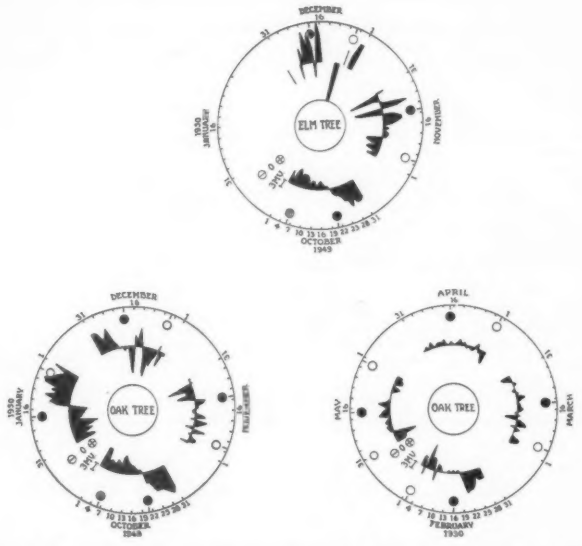


Fig. 11. Algebraic polar coordinate plots showing deviations of daily mean from monthly mean PD for elm and oak trees.

Lower ranges in the C group are probably of some significance, although, as has been indicated, an increased range did not always accompany emotional disturbances. In fact, a disturbed individual whose mean PDs exceed ± 25 millivolts may have a relatively narrow range.

Table III also presents EEGs and continuous DC tracings with accompanying baselines. Relative differences in deviations from the baseline are of no particular importance here as most records were taken at different times. It has been pointed out that head:palm readings are usually positive and are of considerably higher voltage than head:chest PDs. According

to Burr, one reason for this may be distance. Richter believes that the increased number of sweat glands on the palm, with their greater sympathetic innervation, are of prime importance in causing higher PDs, even though high input impedence makes the measurement of these voltage differences independent of resistance charges.[69] Yet, there is no conclusive evidence to demonstrate what part the sympathetic nervous system plays in that picture. As a rule, continuous DC records, which show no discernible alterations with eyes open or closed in the waking state, tend to have small voltage fluctuations. Large random fluctuations, such as in A-8 or B-15, have not been seen frequently in a normal group thus far.[66]

DC electrode placement was established mainly on a trial and error basis. Cephalic bracketing proved unsatisfactory for continuous tracings. At the sensitivity used, one electrode had to be at some point other than the head, probably because the voltage at one point must be changing at a greater rate than at another. Although other placements might yield similar results, experimentation with all possible loci was beyond the scope of this experiment. The 14-17-day cyclic alterations did not appear with finger potential determinations.

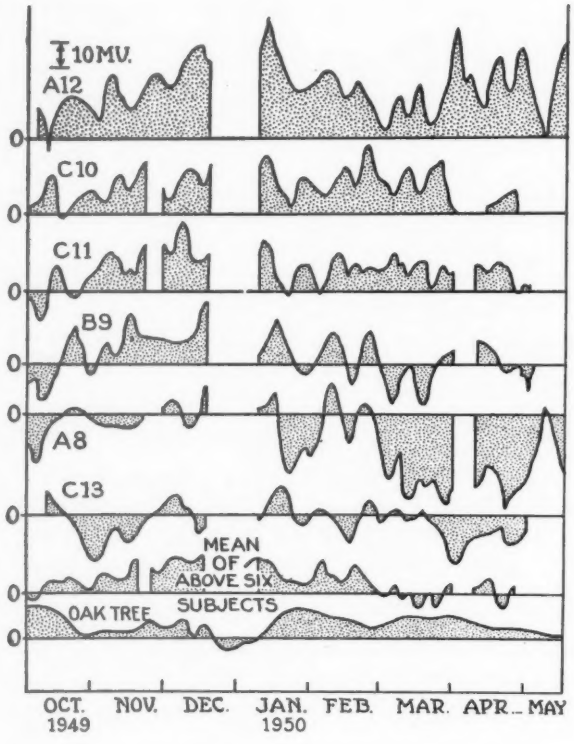


Fig. 12. Algebraic five day running averages of mean daily PDs for 6 subjects and the oak tree.

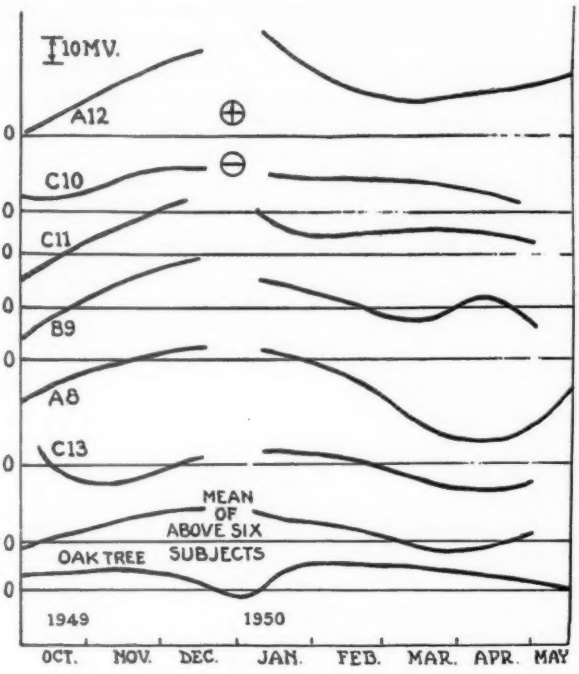


Fig. 13. Algebraic eight month PD trends for 6 subjects and the oak tree.

Alpha index (relative to certain psychologic traits exemplified by Saul and Davis[70, 71]) was predicted in 7 out of 9 EEGs (9 out of 11 including 2 members of the preliminary group: B-2 and C-5). A low index was erroneously predicted for A-12, despite passivity in interpersonal relationships, because of his independence and drive regarding work and autistic tendencies, as low alpha EEGs seem to be prevalent among schizoid personalities and schizophrenics.[47] The phlegmatic appearance and relative isolation of C-11 tended to mask basic, though conscious, passive-dependent tendencies; a low index was also wrongly predicted for him. Both A-12 and C-11 had high alpha indices, as did all males except B-9, in contrast to the 2 females, one of whom had a moderate index and the other showed no alpha whatsoever.* It is of interest to note that the most faithful and conscientious subjects, who related best to the physician (including A-12 and C-11), had high indices. The only exception to this was B-14, who had strong positive and negative feelings due to his unresolved transference. All EEGs were rated by the Davis classification system, which has

*In the preliminary study of 1948, one of the women, B-2, had a low alpha index. Although EEGs were not routinely done at this time, the other 2 would probably have had low indices because of their basically driving aggressive orientation. The Rating of C-5 was also correctly predicted: $3M_{12}$.

been modified and expanded by Derbyshire and Ravitz, on a scale of *1-5*, where *1* denotes a perfectly normal tracing, and *5*, diagnosably abnormal.[46, 48, 49] Subjects were also rated on the same scale as to stability, where *1* and *2* would indicate generally stable individuals, and *4* and *5*, those who were so emotionally-labile that their behavior was unpredictable much of the time. In all but 2 subjects, stability rating and general EEG classification coincided. The two exceptions were B-14, who was rated *3* in stability — EEG classified as *2*, and C-11, who was considered *2* in stability and rated *3* EEG (Table III). In neither of these instances, however, was there a discrepancy or more than 1 division. The most deviant records were those of A-8 and B-17.

The question arises as to the seeming correlation between lunar cycles and periodicity of EMF rise and fall. Belief in the moon's influence on organic life has prevailed at some time in every culture; lunar idolatry even preceded solar. In the 16th century, Paracelsus claimed that the insane grew worse at the time of the new moon when the moon's attraction upon the brain was believed to be the strongest.[75] Such beliefs were legalized in 18th century England. The law expert, Sir William Blackstone, defined a lunatic as: ". . .one who hath . . . lost the use of his reason and who hath lucid intervals sometimes enjoying his senses and sometimes not, and that frequently depending upon the changes of the moon." A distinction was made between "insane," which designated the chronically and hopelessly psychotic, and "lunatic," which was applied to individuals whose mental condition, allegedly exacerbated by the full moon, could be expected to improve at other times. Many terms in all languages such as "menses," "katamenia," "lunacy," etc., originated in connection with the lunar cycle and its supposed effects on mankind. In England prior to 1808, Bethlehem Hospital inmates were beaten at certain lunar periods as a prophylaxis against violence. As late as 1936, it was reported by George Sarton, editor of *Isis*, that special precautions were taken with inmates of a West Indies insane asylum at the time of the full moon.[63] Menstruation, dipsomania, pyromania, migraine, epilepsy, somnambulism, suicides, crimes, blood pH, births, deaths, and sex-ratios have also at various times been related to the lunar cycle.[63, 64, 75]

It is known that certain nocturnal insects are influenced in many of their activities by changing lunar phases with exaggeration of response at the dark or full of the moon;[63] some marine creatures, such as the Palolo worm *Eunice Viridis*, spawn only during the full moon.[10, 63] Others whose activities seem to have lunar periodicity are the *Pleatynereis Domerilli* worm and the common oyster.

The lunar effects on tides is well known. Stetson reported that a gravimeter placed for several months in a fixed location revealed so unequivocally the rise and fall of the earth's crust in response to solar and lunar tides in the earth itself as to render the results unquestionable. He then postulated that if deep focus earthquakes are about to occur through accumulated stresses, there is a better chance of their occurrence when the horizontal tidal component of the moon's gravitational force is at a maximum.[72] Stetson also discovered that a significant relationship exists between lunar phases, solar disturbance, and radio field strength.[73, 74] His graph of observed variation in broadcast-band field strength with lunar

phases closely approximates the 5-day running averages of the subjects. He believes that this might be due to a periodic ionization increase of the earth's upper atmosphere caused by high-energy ultraviolet light and possibly x-rays bombarded from the sun and striking the moon, which in turn reflects photoelectrons and possibly x-rays as invisible radiation. Some atomic disintegration may be effected in lunar surface elements while exposed to high-energy solar radiation; as the moon rotates slowly, any given region is exposed to solar bombardment for 2 weeks at a time. Such a region, due to lunar rotation, could eventually emit radioactive particles contributing to the ionization of the earth's atmosphere,* which would be increasingly ionized during years of sunspot maxima.

It is of interest, therefore, that tree potentials have steadily increased from 1944 — an approximate low in sunspot activity — to a peak during 1948-1949, the years of sunspot maxima. Since the summer of 1949, the trend has started downward as have the sunspots. Considerable work involving a large number of computations was done to determine whether there was any significant relationship between PDs of trees and the azimuth of the moon.[16] As there was no correlation between azimuth and PD, it seems reasonable to assume that, inasmuch as neither subjects nor trees show the most exaggerated responses at the exact time of either new or full moons but usually precede or succeed the first or third lunar phases by 24-72 hours, the ultimate cause is probably due either to inherent protoplasmic rhythms having approximate periodicity of the lunar cycle or both cycles may be the consequence of some more fundamental cosmic factor acting upon both responding systems. In any event, as is further evidenced by the mean of 6 human subjects, all humans seem to respond at approximately the same time to the same exogenous or endogenous factors causing a rise or fall in PD. This might provide some scientific basis for lunar myths.

The PD of the entire group was gradually rising through November and December. This was especially a period of great emotional disturbance for A-12, whose PD increased at an accelerated rate far above that of the others during this time. A-8 was in almost constant turmoil during March and April. His high negative readings occurred simultaneously with an EMF decrease in the other subjects, and although unresolved conflicts continued, he felt and acted better when his PD began to decrease in negativity during May. Unfortunately, it was necessary to stop readings in May. There was some indication that A-12 and C-13 were also beginning to show signs of increasing positivity at this time. C-10 and C-11, whose PDs had been decreasing until April, tended to level off and, had their readings been continued through May, it is possible that they, too, would have begun to show increased PDs. This suggests that emotional disturbances may, at least sometimes,

*In September, 1944, New England was visited by a second hurricane, in this area not nearly so severe as in 1938, but more severe than is usual in September. At the time, simultaneous records were taken from two widely separated trees in New Haven and Old Lyme, Connecticut. These showed sharp increased positivity of the upper electrode greatly in excess of any previous records for this time of the year, which appeared 24-48 hours before the actual storm. Had this happened in only the Lyme tree, little could be made of the finding, but since it occurred also in the New Haven tree, the probability is increased that this is of significance — again suggesting some relationship between the electrical properties of the atmosphere and the field properties of living systems.[16]

be precipitated by two general factors; one obviously dealing with the structure of the individual himself faced with certain life situations and the other with universally present exogenous or endogenous forces acting upon or within him. Although this is highly speculative, it seems entirely possible that a neurotic whose head tends to be positive to his chest might manifest greatest conflict and emotional disturbance at the time there is a general trend toward increased positivity and be most adjusted when there is a trend toward decreased positivity (negativity), whereas the opposite might hold true for one whose head was usually negative to his chest. It is also possible that an individual who becomes maladjusted will show increased positivity or negativity, depending upon the general cyclic trend at that time, although from the general consistency of polarity in 6 subjects over a 7-month period, the former would probably be a more valid postulation than the latter. Considerably more work must be done before this can either be ruled out or accepted as a valid hypothesis.

As can easily be seen, isolated PDs are relatively meaningless; they can assume significance only when taken daily over a long period of time and related to the individual's cycles. At a time when so-called dynamic concepts are accorded considerable weight in psychiatric circles, it seems evident that no individual can be completely assessed without considering him in relation to his own particular cyclic pattern.

It is still obscure as to what chemical entities either give rise to or modify PDs, although many studies have been made of such processes as electrolyte balance and ionic transport in the hope that they might indicate the source, meaning, and significance of these differences. As membrane potentials across cell walls are in the order of 50-100 angstrom units thick, the equivalent voltage amounts to 100,000-200,000 v/cm.[18] Such voltages must be important factors in living systems. As it is generally accepted that potentials across cell walls are a consequence of differences in electrolyte concentrations on opposite sides of the wall, such phenomena can be explained partially by known differences in electrolyte concentration and by ionic motility across phase boundaries. Yet, although the importance of cell chemistry cannot be denied, attempts to explain PD on chemical grounds alone have been unsatisfactory. Lund has indicated that cellular chemical activity provides electrical current which may be stored either as resting potential or utilized in activity, e.g., in nerve fibers. As PDs increase during growth of plant and animal embryos until a maximum is reached and, when corn and cotton seeds are measured, indicate quantitatively the future plant size and productivity, Burr feels that they may represent a reservoir of stored energy which can be rapidly drained to meet the exigencies of activity[9, 12, 18] and might be conceived as an index of vigor. Using this hypothesis, it is not surprising to find less voltage fluctuations in middle-aged trees, mice, and men.

Experimental evidence supports the theory that, whatever else they may be, all protoplasmic systems which have been examined represent one aspect of quasielectrostatic fields, exhibiting a definite pattern of PD as a whole. Thus, energy reserves may be mobilized both by emotional disturbances and by unknown periodic universal factors, which tend to aggravate maladjustments and conflicts *already present*. PD measurements over a consider-

able period of time seem to furnish a rough quantitative index to the severity of emotional disturbances. These findings suggest that there can be no adequate behavioristic theories which do not strive to integrate the concepts of modern field physics in order to view all living systems as part of a universal whole responding to fundamental forces, which impart design to living and non-living systems alike.

SUMMARY

Daily DC head:chest spot determinations were made on 17 subjects consisting of 6 women and 11 men, 10 of whom were studied from 2-8 months. The studies included temperature, blood-pressure, pulse, continuous DC records, finger potentials, EEGs, and psychiatric evaluations. The subjects were arbitrarily classified in 3 divisions, depending upon their general adjustment to life situations: *A.* the severely maladjusted, B. the moderately maladjusted, and C. the reasonably well-adjusted. Four showed signs of severe maladjustment, 6 were placed in the intermediate group, and 7 (despite possible behavior deviations) were reasonably well-adjusted. In the final study, results were plotted both as absolute values and with signs.

1. DC spot determinations:

(a) In all subjects, 14-17-day cycles were present which roughly correlated with the first and third lunar phases. A double spike preceding and following the lunar day was sometimes encountered. Occasionally, a high circumscribed potential focus would appear on one side of the head at such times. Four month cycles were also evidenced. In addition, 6-week and 7-9-day cycles were seen in 2 subjects.

(b) The normal monthly mean for 1949-1950 was roughly —7 to + 18 millivolts, or when plotted as absolute voltage gradients, 8 to 18 millivolts.*

(c) Consistently high PDs exceeding —10 or +20 millivolts were associated with emotional disturbances and tended to occur at the time *all* subjects were either increasing or decreasing in negativity or positivity respectively.†

(d) In 6 subjects, subjective or objective changes could be associated with high isolated PDs: C-5, C-10, and B-15 generally felt more tense at such times; A-8 tended to become diffusely hyperactive, tense, facetious, and emotionally-labile; A-12 appeared more withdrawn, apathetic, and autisitic; and B-14 became sullen, withdrawn, preoccupied, and irritable. Unusually vivid dreams often occurred the night preceding or following high potential readings.

*From observations of tree potentials, it seems possible that the average monthly mean may be higher in years of sunspot maxima.

†Later studies confirm these observations and show that psychotics have considerably higher DC voltages than normal individuals.[68]

(e) The head was usually positive or slightly negative to the chest; high negative readings were less frequent than high positive readings. Individuals showing high negative potentials tended to feel and act better when low positive readings were obtained, and vice versa.

(f) The group average maintained the same cyclic pattern seen in individuals, which (as in individual subjects) was more marked when polarity was taken into account.

(g) The exact significance of polarity is yet to be explained; however, in most subjects there was a gradual persistent positive PD increase from October through the middle of January, a general decrease from January until May, and again, a beginning increase at that time.

(h) Although the cycles appear more significant when plotted with respect to signs, the monthly means correlate better with emotional disturbances when determined as absolute values and approximate those obtained in the preliminary study.

(i) There were less voltage fluctuations in an older subject. During March, considerably greater scattering appeared in both trees and subjects; voltage fluctuations were minimal in April.

(j) Isolated DC spot determinations were relatively meaningless unless taken daily over a long period of time and related to the individual's cycle.

(k) There was some tendency for emotional disturbances to correlate with increased monthly ranges, although this was not invariably true. However, the most adjusted group had the lowest average ranges: 41.5 to 48.4 millivolts. The average monthly ranges of the other groups were: 58.8 to 76.6 millivolts.

2. Comparisons:

(a) Trees showed similar cyclic alterations (sometimes mirror images of human cycles), despite considerably decreased voltage fluctuations and increased polarity stability.

(b) Similar lunar variations were later demonstrated in a group of mice.

(c) DC finger potentials did not produce the same cyclic alterations as did head:chest determinations and could not be related to emotional disturbances.

(d) There was no apparent correlation with DC measurements and temperature, blood-pressure, and pulse, or with local variations in the external environment, such as temperature, barometer, humidity, weather and sunlight.

(e) Stability of DC cycles in general seemed to correlate with stability of continuous DC tracings, EEG patterns, personality stability, and with certain psychologic tendencies exemplified by Saul and Davis. Periods of emotional instability were often associated with extreme lability of the readings. Those whose basic orientation was toward passivity and dependence showed high alpha indices; those who were basically active, driving, and independent had low indices or showed no alpha whatsoever. Including 2 members of the preliminary group, 9 out of 11 EEGs were predicted correctly as the alpha index.

3. There is evidence to suggest that not only can emotional disturbances increase PDs, but unknown factors acting upon all living systems may at periodic intervals precipitate or aggravate already present disturbances. It seems probable that no individual can be completely assessed without considering him in relation to his own particular cyclic pattern. This study suggests that there can be no adequate behavioristic theories which do not strive to integrate the concepts of modern field physics in order to view all protoplasmic systems as part of a universal whole, responding to fundamental forces which impart design to living and non-living systems alike.

ACKNOWLEDGMENTS

The author is indebted to Dr. Harold S. Burr for promoting these original studies at Yale; Mr. Bertram G. Bruestle, who produced the graphs; and Mr. Henry Antz, technical adviser. Great appreciation is also expressed to Dr. Richard S. Lyman for his helpful comments, Dr Elias F. Mengel, Jr., and Mrs. Barbara A. Anderson for secretarial assistance.

RESUMEN

Se hicieron determinaciones localizadas diarias de la corriente continua del circuito cabeza-tórax en 17 individuos de los cuales 6 eran mujeres y 11 hombres. Diez de éstos fueron estudiados durante 2-8 meses, incluyendo temperatura, presión sanguínea, pulso, registro continuo de la corriente continua, potenciales de los dedos, electro-encéfalogramas y apreciaciones psiquiátricas. Los individuos se clasifican arbitrariamente en 3 grupos de acuerdo con su facultad de adaptación general a las situaciones de sus vidas: Grupo A, intensamente inadaptados; Grupo B, moderadamente inadaptados y Grupo C, razonablemente bien adaptados. Cuatro presentaron manifestaciones de intensa inadaptación; 6 se colocaron en el Grupo intermedio y 7 (a pesar de las desviaciones posibles de su modo de ser) se consideraron bien adaptados. En los resultados finales se anotaron gráficamente sus determinaciones, tanto en valores absolutos como considerando los signos de la polaridad.

1. Determinaciones localizadas de la corriente continua:

a. En todos los individuos se presentaron ciclos de 14 a 17 días que, aproximadamente, se correlacionaban con la primera y tercera fase lunar. Algunas veces se encontró una doble elevación en aguja antes o después del día lunar. Ocasionalmente se presentó un foco de alto potencial circunscrito a un lado de la cabeza durante esta época. También

pudieron observarse ciclos de 4 meses. Además, en 2 individuos se observaron ciclos de 6 semanas y de 7-9 días.

b. El promedio mensual normal en 1949-1950 fué, aproximadamente, de —7 a +18 milivoltios, o sea, anotado en el gráfico como gradiente de voltaje absoluto, de 8 a 18 milivoltios.*

c. Uniformemente, las D. de P. altas que sobrepasaban de —10 ó +20 milivoltios se relacionaban con trastornos emocionales y tendían a presentarse, en *todos* los individuos, con aumento o disminución de la negatividad o positividad, respectivament.†

d. En 6 individuos, las variaciones subjetivas y objetivas podrían guardar relación con D. de P. aisladas altas: C-5, C-10 y B-15, por lo general, se sentían más tensos en estas oportunidades; A-8 tendía a ponerse hiperactivo, difuso, tenso, chistoso y emocionalmente lábil; A-12 se presentaba más retraido, apático y egocéntrico, y B-14 se ponía hosco, retraído, preocupado e irritable. Los sueños excepcionalmente vívidos, a menudo, se producían la noche anterior o siguiente a las lecturas de elevados potenciales.

e. La cabeza, por lo general, fué positiva o ligeramente negativa con respecto al tórax; las lecturas negativas elevadas fueron menos frecuentes que las positivas altas. Los individuos que presentaban potenciales negativos elevados tendían a sentirse y a actuar mejor cuando las lecturas eran positivas bajas y *viceversa.*

f. El promedio del grupo conservó el mismo tipo cíclico observado en cada individuo, el cual (en cada individuo) fué más acentuado cuando se tomaba en cuenta la polaridad.

g. El exacto significado de la polaridad está aun por explicarse; sin embargo, en la mayoría de los individuos se presentó un aumento gradual y persistente de D. de P. positiva desde octubre hasta mediados de enero, una disminución general desde enero hasta mayo y, de nuevo, un aumento inicial desde esta época.

h. Aun cuando los ciclos se aprecian mejor cuando se anotan en el gráfico con consideración de los signos, los promedios mensuales se relacionan mejor con los trastornos emocionales cuando se determinan como valores absolutos que se acercan a los obtenidos en el estudio preliminar.

i. Hubo menores fluctuaciones de voltaje en un individuo de mayor edad. Durante marzo se presentó una considerable mayor dispersión del voltaje, tanto en individuos como en árboles; en abril las fluctuaciones de voltaje fueron mínimas.

j. Las determinaciones localizadas aisladas de la corriente continua fueron, relativamente, sin significación a menos que se tomaran diariamente durante un largo período y se relacionaran con el ciclo del individuo.

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*De las observaciones de los potenciales de los árboles, parece posible deducir que el promedio de los términos medios de cada mes, puede ser más alto durante los años de máxima actividad de las manchas solares.

†Estudios posteriores confirman estas observaciones y demuestran que los psicóticos presentan voltajes de corriente continua considerablemente más altos que los individuos normales.

k. Existe cierta tendencia de los trastornos emocionales a guardar relación con los aumentos de la escala de variaciones mensuales; sin embargo, esto no siempre fué verídico. No obstante, el grupo de individuos mejor adaptados presentó la escala de promedio más bajos: 41,5 a 48,4 milivoltios. El promedio de las escalas mensuales de los otros grupos fué: 58,8 a 76,6 milivoltios.

2. Comparaciones:

a. Los árboles presentaron alteraciones cíclicas similares (a veces, copia fiel de los ciclos humanos), a pesar de la disminución considerable de las fluctuaciones del voltaje y del aumento de la estabilidad de la polaridad.

b. Posteriormente, se pudieron demostrar variaciones lunares similares en un grupo de ratones.

c. Los potenciales de corriente continua de los dedos no revelaron las mismas alteraciones cíclicas que las reveladas por el circuito cabeza-tórax, y no pudieron ser relacionadas con los trastornos emocionales.

d. No hubo una correlación manifiesta entre las determinaciones de la temperatura, presión sanguínea y pulso, o con variaciones locales del ambiente exterior, tales como temperatura, presión barométrica, grado de humedad, condiciones atmosféricas y luz solar.

e. La estabilidad de los ciclos de corriente continua, en general, parece relacionarse con la estabilidad de los trazados continuos de corriente continua, los tipos de electroencéfalogramas, estabilidad de la personalidad, y con ciertas tendencias psicológicas puestas de relieve por Saul y Davis. Los períodos de inestabilidad emocional se relacionaron, a menudo, con la extrema labilidad de las lecturas. Aquéllos cuya orientación básica se inclinaba hacia la pasividad y dependencia, presentaron índices alfa elevados; aquéllos que eran básicamente activos e independientes, presentaron índices bajos o no los presentaron. Incluyendo 2 individuos del grupo preliminar, 9 de 11 electroencéfalogramas pudieron ser pronosticados correctamente a través del índice alfa.

3. Existe la evidencia para sugerir que no sólo los trastornos emocionales pueden aumentar las D. de P., sino que factores desconocidos, actuando sobre los seres vivos, pueden, a intervalos periódicos, precipitar o agravar los trastornos preexistentes. Parece probable que ningún individuo puede ser completamente valorizado sin considerarlo en relación con su propio tipo cíclico particular. Este estudio sugiere que no pueden existir teorías de conducta adecuadas sin que traten de integrar los conceptos de la física moderna para considerar todo sistema protoplasmático como parte integrante del universo y que responde a las fuerzas fundamentales que imparten los designios de los seres vivos, como asimismo de los sistemas inanimados.

RESUME

On a procédé à des déterminations quotidiennes par CC en divers points de la tête et de la poitrine sur un groupe de 17 sujets composés de 11 hommes et de 6 femmes, dont 10 ont été étudiés pendant une période de 2 à 8 mois. Ces études ont porté sur la température, la pression sanguine, le pouls, les enregistrements CC continus, les potentiels des doigts, les électroencéphalogrammes (EEG), et les évaluations psychiatriques. Les sujets étudiés ont été classés arbitrairement en 3 catégories, selon leur adaptation générale aux situations créées par la vie: (A) les sujets très mal adaptés; (B) les sujets moyennement mal adaptés; et (C) les sujets assez bien adaptés. Sur le groupe total, 4 ont accusé des signes marqués de manque d'adaptation, 6 ont été classés dans la catégorie intérmédiaire, et les 7 autres (malgré des écarts éventuels de comportement) ont été considérés comme relativement bien adaptés. Dans l'étude finale, les résultats des observations ont été relevés en tant que valeurs absolues et avec leurs signes correspondants.

1. Déterminations au CC par points:

(a) Chez tous les sujets, on a noté des cycles de 14-17 jours correspondant approximativement à la première et à la troisième phase lunaire. Une double pointe précédant et suivant le jour lunaire a été parfois enregistrée. Dans certains cas, on a observé à ce moment là un haut foyer potentiel circonscrit d'un côté de la tête; des cycles de 4 mois ont également été mis en évidence. En outre, chez 2 sujets on a noté des cycles de 6 semaines et 7-9 jours.

(b) La moyenne mensuelle normale en 1949-1950 a été approximativement de —7 à +18 millivolts, ou lorsqu'elle a été relevée en valeurs absolues de voltage, de 8 à 18 millivolts.*

(c) On a observé régulièrement que de fortes différences de potentiel (DP) dépassant en valeur —10 ou +20 millivolts étaient associées à des troubles émotifs et tendaient à se produire au moment où *tous* les sujets accusaient ou bien une augmentation ou bien une diminution, respectivement en valeur négative ou en valeur positive.†

(d) Chez 6 sujets, des changements subjectifs ou objectifs ont pu être associés à des différences de potentiel (DP) isolées de forte valeur: à ces moments-là, C-5, C-10 et B-15 ressentaient en général une tension plus forte; A-8 tendait à manifester une activité outrée et éparpillée, et un esprit tendu, facétieux et émotivement instable; A-12 s'est montré plus renfermé, plus apathique et sujet au narcissisme; et B-14 est devenu maussade, renfermé, préoccupé et irritable. Des rêves d'une vividité remarquable ont fréquemment troublé le sommeil des sujets au cours de la nuit qui a précédé ou suivi le jour où l'on a relevé les hautes valeurs de potentiel.

(e) La tête des sujets était en général positive ou légèrement négative par rapport

*D'après les observations de potentiels relevées pour les arbres, il semble possible que la valeur moyenne mensuelle puisse être plus élevée pour les années de taches solaires maxima.

†Des études ultérieures ont confirmé ces observations et montré que les psychotiques accusent des voltages de CC beaucoup plus élevés que les sujets normaux.[68]

à la poitrine; les cas accusant de forts potentiels négatifs tendaient à se sentir et à se comporter mieux lorsqu'on a relevé de faibles valeurs positives, et réciproquement.

(f) La moyenne du groupe a maintenu le même type cyclique que celui observé pour les cas isolés; ce type (comme pour les sujets pris isolément) était plus marqué losqu'on a tenu compte de la polarité.

(g) L'importance exacte de la polarité reste encore à déterminer; toutefois, chez la plupart des sujets, on a observé une augmentation persistante et graduelle de la DP positive entre octobre et le milieu de janvier, une diminution générale de janvier à mai, et de nouveau la reprise de l'augmentation à partir de ce moment-là.

(h) Bien que les cycles soient plus nettement marqués lorsqu'on les relève en relation avec les signes, les moyennes mensuelles correspondent plus étroitement avec les troubles émotifs lorsqu'on les détermine comme valeurs absolues et elles coïncident approximativement avec celles de l'étude préliminaire.

(i) On a observé des fluctuations de voltage plus faibles chez un sujet âgé. Au cours du mois de mars, on a noté une dispersion beaucoup plus grande tant chez les arbres que chez les sujets; les fluctuations de voltage ont été minima en avril.

(j) Les déterminations locales isolées au CC se sont montrées relativement dénuées de sens, sauf lorsqu'elles ont été faites quotidiennement pendant une longue période de temps et qu'elles ont été rapprochées du cycle particulier du sujet considéré.

(k) Il a été observé que les troubles émotifs tendaient à augmenter parallèlement à l'accroissement des gammes mensuelles, bien que cela n'ait pas été vrai dans tous les cas. Quoi qu'il en soit, le groupe le mieux adapté a accusé les plus faibles gammes moyennes: 41,5 à 48,4 millivolts. Les gammes mensuelles moyennes enregistrées par les autres groupes ont été de 58,8 à 76,6 millivolts.

2. Comparaisons:

(a) Les arbres ont accusé des modifications cycliques de nature similaire (parfois des répliques fidèles des cycles humains), malgré une diminution considérable des fluctuations de voltage et un accroissement de la stabilité de polarité.

(b) Des variations lunaires similaires ont été ultérieurement démontrées par un groupe de souris.

(c) Les potentiels CC appliqués aux doigts n'ont pas donné les mêmes modifications cycliques que les déterminations relatives à la tête et à la poitrine, et on n'a pas pu établir pour eux de relation avec les troubles émotifs.

(d) Il n'a pas été noté de correspondance visible entre les mesures CC et la température, la pression sanguine et le pouls, ou avec les variations locales du milieu extérieur, telles que température, pression barométrique, humidité, intempéries et lumière solaire.

(e) D'une manière générale, la stabilité des cycles CC a paru coïncider avec la stabilité des tracés CC continus, les types enregistrés par les électro-encéphalogrammes (EEG), la stabilité de la personnalité, et avec certaines tendances psychologiques mises en évidence par Saul et Davis. Les phases d'instabilité émotive ont souvent été associées avec une

instabilité marquée des lectures d'instruments. Les sujets dont la tendance fondamentale était vers la passivité et la dépendance ont accusé des indices alpha élevés; ceux qui étaient essentiellement actifs, indépendants et autoritaires ont accusé de faibles indices ou même n'ont enregistré aucune valeur alpha. Y compris 2 membres du groupe préliminaire, 9 électro-encéphalogrammes (EEG) sur 11 ont été prédits correctement comme index alpha.

3. Les observations faites suggèrent que les différences de potentiel peuvent augmenter non seulement sous l'effet des troubles émotifs, mais encore par suite de facteurs inconnus agissant sur tous les systèmes vivants et qui peuvent, à des intervalles périodiques, précipiter ou aggraver des troubles déjà existants. Il semble probable qu'il n'est pas possible d'évaluer complètement un sujet, quel qu'il soit, sans l'envisager en relation avec son type cyclique particulier. Cette étude suggère qu'on ne peut pas concevoir des théories de comportement qui ne visent pas à intégrer les notions de la physique moderne d'induction afin de concevoir tous les systèmes protoplasmiques comme faisant partie d'un tout de caractère universel, réagissant à des forces fondamentales qui communiquent un dessein aux systèmes vivants tout comme aux systèmes non-vivants.

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The Neuro-Dynamic Aspect of Schizophrenia

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It may safely be stated that every psychiatrist has used the term "blocking" in discussing the acute form of schizophrenia, the catatonic. The object of this paper is to point out the fact that this blocking, conceived in terms of neuro-dynamics, throws a surprising light upon all the manifestations of dementia praecox.

Let us, for convenience, use the term blocking as descriptive of any form of interference with the propagation of nerve currents in a certain direction, whether this is due to pathological conditions, such as hemorrhage, drugs, toxins, etc., or to normal physiological functions as those described by the term of inhibition.

Data to be mentioned later show that whatever the nature of the blocking, its effects are—in many cases, at least—either of the following: (1) Stimulation of the part after the removal of the cause of the blocking; (2) stimulation of a related part and, at times, a condition that brings about the reversal of the effects of stimuli.

The following are examples of reversal due to pathological blocking:

1. Adrenalin stimulates the sympathetic division of the autonomic nervous system. "If we inject an animal with ergotoxin, we block the paths of the sympathetic system. If we then inject adrenalin, the latter will not be able to travel along the ordinary pathway . . . it will provoke just the opposite . . . adrenalin will (then) irritate the parasympathetic system."[9 (518)]

2. Interference with the upper part of the motor tract, as in the case of cerebral hemorrhage, results in the reversal of the toe reflex—the familiar Babinski phenomenon.

3. According to Pavlov, "In lesions of the cortex . . . which follow extirpations, the positive conditioned stimuli belonging to the injured cortex become inhibitory."[7 (364)]

Reversal is also found in physiological blocking of those brain areas involved in consciousness, that is, in cases of blocking by inhibition. According to Pavlov, the status of sleep is a form of inhibition identical with the inhibition in conditioned reflexes.[6 (251)] In his experiments he found that "peculiar conditions were observed in cases of intense drowsiness which fell short of changing into complete sleep. While positive conditioned stimuli had lost their effect, well developed negative stimuli acquired excitatory properties."[6 (275)]

Before taking up the discussion of the other indirect effects of blocking by inhibition, let us consider the role of inhibition in general.

Sherrington stated the following: "In all these uses of inhibition we see it as an associate of, and a counterpart or counterpoise to, excitation. Whether we study it in the more primitive nervous reactions which simply interconnect antagonistic muscles, or in

the latest acquired reactions of the highly integrated organisms, inhibition does not stand alone but runs always alongside of excitation."[11(309)]

On the basis of his findings, Pavlov concluded that inhibition is as active a process as excitation; that while it serves to prevent exhaustion, it cannot always be considered as being caused by exhaustion, since it is induced also in cells that have not previously been in a state of exhaustion.[6(244)]

Thus we see that that part of the brain involved in an activity is partly, at least, bipolar—one pole being in the excitatory, the other in the inhibitory phase. Considering the interdependence of their activities, we expect to find that either pole can be activated excitatorily or inhibitorily by an influence exerted on the opposite pole. And such is really the case. Sherrington applied the term induction to this form of influence. Pavlov corroborated the dynamics of induction. He stated: "Induction is mutual or reciprocal: excitation leading to increased inhibition and inhibition leading to increased excitation."[6(188)]

The following are examples of successive (temporal) induction:

According to Best and Taylor, "Successive induction may be positive or negative. . . . The flexion reflex (contraction of the flexors and the relaxation of the extensors of a limb) favors the succeeding extensor reflexes (the contraction of extensors and extension of the flexors) which in turn lower the threshold of the next flexion reflex.[1(813)]

"Induction is a feature of conditioned reflex action analogous to the phenomenon of the same name described as occurring in spinal reflexes, namely, the increased inhibition caused by a preceding state of excitation (negative induction) or an increased excitation caused by a previous state of inhibition (positive induction)."[1(914)]

Reid Hunt found that the stimulation of the vagus after the stimulation of the accelerans, retarded the pulse more than before.[4]

One discerns phenomena of induction in the functions of the autonomic nervous system. "We must consider some interesting data by Weinberg. He found that with every increase of attention, i.e., of the level of consciousness, there occurs a reaction of the parasympathetic system. This parasympathetic reaction is then again followed by an increased activity of the sympathetic system."[10(512)]

So analogous to the above are the phenomena of alternating after-images that one is led to believe that these also are manifestations of induction. After looking at a bright red light, as that of the sunset, one sees first a (positive) red after-image, then a (negative) green after-image, then again red, etc. Whether one accepts the Young-Helmholtz theory of color vision, or that of Herring, or any one of the others, one cannot overlook the possibility that induction is a factor in the alternating after-images.

I recall reading the news on the Times Building in New York City. The line of letters, consisting of electric lights, moved from right to left. The background, therefore, seemed to move from left to right. For a brief period after the letter-lights were turned off, the background seemed to move—opposite from its former direction—from right to left.

According to Burton-Opitz, "The relaxation of a previously contracted muscle very frequently incites the contraction of the relaxed antagonistic muscle."[2(592)]

The following are examples of simultaneous (spatial) induction:

Pavlov found that excitation[6(181)] and inhibition radiate from the point of origin, and that especially inhibition proceeds "in a wave-like manner both in regards to time for a given place and in regards to space for different cortical points simultaneously."[6(214)] He also found that in some cases of spreading inhibition, this inhibition is preceded by a wave of excitation.[6(215)] He offered the following as an explanation of the inhibition of conditioned reflexes by outside stimuli: "External inhibition might be due to negative induction, that is to the inhibition which is induced in the cortical area neighboring on the area of excitation."[6(276)]

Elsewhere Pavlov stated: "There exists such a relation—an excitation arising in a certain place causes an inhibitory process around this region, and owing to this the spread of the original excitation becomes limited. On the other hand the inhibitory process produces an excitatory process and this in turn checks the spread of inhibition."[7(333)]

Positive simultaneous induction is apparently behind the phenomena of dream formation. The onset of sleep is not sudden. According to Burton-Opitz, "In the process of falling asleep some parts of the central nervous system remain more active than others, and this is true even of the cerebral cortex. . . . The motor centers become inactive before the sensations have been lost entirely."[2(722)] This is in keeping with Pavlov's statement that the processes of falling asleep "proceed more or less gradually."[7(314)]

According to Best and Taylor, "Dreams occur only during light sleep, at a time when one would expect the internal inhibition process to be restricted to the more highly specialized analyzers and before it has spread to involve the entire cortex."[1(219)]

Whether or not one accepts Pavlov's theory that sleep is identical with internal inhibition of conditioned reflexes, since we find that any type of blocking gives rise to induction, we expect the same to be true in the case of the spreading of the status of sleep. Whether we imagine the advancing flood-edge, or flood-fringe, of sleep to be straight, curved or circular, we are certain (the shape of the brain being what it is) that there results, before the final engulfment, the formation of an island that is completely surrounded by inhibition—an inhibition which, advancing from all directions, is preceded in time and space by a wave of excitation, the latter becoming highly concentrated in that island. It is readily imaginable that such a concentration of excitation may lead to results closely resembling those of electrical or other forms of irritation applied to the cortex. It is, therefore, highly plausible to assume that this concentration of excitation is the substratum of dream formation. Dreams occur at the point of falling asleep and at the point of awakening. In the former instance the island is soon to become engulfed. In the latter instance the island is soon to become a "continent." Dreams may occur also during an episode of shallow sleep in the course of deeper sleep, shallow sleep that does not result in complete awakening.

According to Pavlov, "The dissolving excitation by inhibition, as well as the transformation of the waking state into sleep, is attended by a temporary general excitement. Probably this is the positive phase of induction: *viz*, the initial inhibition immediately

provokes in the remote regions excitation, which is suppressed, however, through the continuous effect of the inhibiting sleep-producing agent."[7(316)]

One may safely say that there are also motor dreams—presumably due to the formation of the island in the motor area. Many, if not most, people experience myoclonic movements in some part of the body at the point of falling asleep. With some people these myoclonisms are so extensive that they describe them as near-convulsions.

"It was often observed in the experiments of Dr. Rosenthal that when a neutral stimulus evoked definite drowsiness in a puppy, and before the animal completely fell asleep, it passed through a fleeting phase of excitation, moved about uneasily, stretched itself and barked without obvious reason."[6(263)]

It is apparent that in hypnosis there is also the formation of an island of excitation induced, or strengthened, by the surrounding inhibition. This explains why in hypnosis one can induce hallucinations and bring about the revival in memory of events that otherwise cannot be recalled. According to Schilder and Kauders, "Close relation exists between certain pharmacotoxic effects, sleep, hypnosis and memory. In the first place we must mention that material long forgotten frequently crops up again in sleep. It is too well known that in an intoxication the experience of an earlier intoxication may be recalled. . . . Finally soporifics have been of excellent service in the elimination of stubborn amnesias."[10(68)]

In anesthesia, such as that due to ether, there is a period of excitation preceding that of the final complete relaxation.

One perceives that the manifestations of induction by sleep are similar to those induced by other agencies, electrical stimulations, for example. By applying an electrode to the exposed occipital lobe of an epileptic girl, Penfield succeeded in reactivating the patient's epileptic aura. This aura consisted of the revisualization of an actual frightening event that had taken place in that girl's childhood: Somebody wanted her to get into a bag containing snakes. The stimulation of another part of the cortex of the same patient caused her to say that a crowd of people were shouting at her. "They are yelling at me for doing something wrong," she cried.[8]

Forester reported that a stimulus applied at the rear of the visual area caused the patient to see integrated images, such as flames, stars, human beings, etc.[3]

In the stimulation of the substrata of memories during the revival in mind of bygone events, the parts of the scenes which belong to each other, are integrated by their original contiguities or other associative links. Such is not always the case in instances of pathological irritation. In epilepsy, for example, the interrelations of the parts stimulated may be essentially anatomical, as was pointed out by Penfield.[8] The irritant is apt to stimulate fragments of a number of memories simultaneously. The result may be a fusion of incongruous elements. Yet even in such cases there may be almost-integrated or completely integrated wholes, the brain supplying the elements for what the gestaltists call the closure of incomplete—open—gestalten.

The same is true of dream formation.

In schizophrenia there is an almost point-to-point correspondence to the data mentioned above — to the indirect results of blocking.

The following are brief abstracts of two cases of catatonic dementia praecox, for illustration. (Abstracts of more cases illustrating *all* the symptoms found in dementia praecox would occupy too much space.)

CASE OF W.O.

First attack. History of alcoholism and of a series of arrests for larceny. I.Q. 54. After admission the patient was stuporous. He kept on mumbling to himself. Mutism developed. Eventually he refused to eat. He resisted force-feeding. But as soon as a few drops of milk reached his mouth from the cup whose edge was placed between his lips, he drank the rest avidly. This happened again and again. It was obvious, therefore, that he did experience hunger. After the first few electro-shock treatments the patient became alert and responsive. He ate his food ravenously. His explanation of his mutism and of his refusal of food was the following: "I could not eat and I could not talk." No further data on this subject could be elicited from the patient.

CASE OF J.F.G.

History of repeated attacks of schizophrenia with some of the intervals lasting years. The manifestations varied from those of stupor to those of extreme excitement. Some time after his admission, while in a much improved state, he gave the following account of one of his experiences during one of his acute attacks: Within a few minutes after he was placed therein, he got out of his bed with the intention of walking over to the window. But instead of walking forward, he kept on stepping backward, facing the window which he intended to approach. He offered the following highly illogical explanation of his peculiar behavior: On his way to the hospital he was handcuffed and his arms were restrained against his sides. The after-feeling of that restraint was what caused him to step backward instead of forward, during those few minutes.

In the catatonic type of dementia praecox, which is the most acute form of that disease, thought-blocking is decidedly obvious. And it is in this type that reversal, in the form of negativism, is manifest. The patient is apt to shut his mouth tighter when asked to open it and to open his mouth when asked to close it. The backward stepping, instead of forward stepping, in the cast of J.F.G. was surely a case of reversal. W. O.'s refusal to take food while starved and hungry was another instance of reversal. This explanation holds good even if you assume that the patient's refusal to talk and to take food was based on a paranoid attitude — on fear of being found out and fear of being offered food that was poisoned. A highly unreasonable and ineradicable paranoid attitude is in itself a manifestation of reversal. One often finds the formerly devoted son developing the delusion that his mother is attempting to poison him or shoot him. That the normal child develops a sense of confidence in, and a friendliness toward, his parents goes without saying. The human being is a gregarious animal. Even when he finds himself in an actually hostile environment, he has the sense — a distinct or vague belief — that somewhere there may be potential friends. The paranoid schizophrenic does not seem to feel that way.

The indulgence by some schizophrenics in habits that are repulsive to normals (and even to animals) such as coprophagia, is obviously another manifestation of induction in the form of reversal.

Finding reversal in the case of blocking in the motor field (Babinski), in the autonomic field (blocking of the sympathetic by ergotoxin), and in that field which is the source of consciousness (blocking by sleep), one readily concludes that the manifestations of schizophrenia mentioned above are of the same nature. And there is corroborative evidence in the fact that Landkof[5] demonstrated conditioned reflex reversal in the vaso-motor field in dementia praecox.

Apply the interpretation of dream formation to the symptomatology of schizophrenia where there is unmistakable blocking, and you will discern the reason for the hallucinations and the automatic and the semi-automatic activities found in that disease.

The similarity of the hallucinations of the schizophrenic to the phenomena of dreams has been mentioned by a number of writers. In either case, the stimulation which is the result of induction is not limited to elements which are interrelated psychologically. Because of this there are fusions of incongruous elements. In either case the stimulation may be limited to sub-wholes, the rest being cut off by blocking. It is imaginable that in the case of schizophrenia the part indirectly stimulated constitutes a secondary focus of consciousness.

It is apparent that the processes of judgment are the same as, or are similar to, those involved in the synthesis of sub-wholes into wholes. Three lines interrelated in a certain way are synthetized into — are perceived as — a triangle (three lines plus a triangle: something added.) Similarly, the sight of a wrecked car plus the sight of an approaching ambulance are synthetized into the judgment that someone in that car was injured. That synthesis depends upon the activities of nerve elements is obvious from the fact that in some cases of cortical injury, as those due to cerebral hemorrhage, the synthesis of sub-wholes into whole configurations is greatly impaired. In the case of stimulation of a limited area surrounded by blocking there are not enough neurone elements required for efficient synthesis. Hence, the impaired judgment in relation to the hallucinatory experiences in schizophrenia as well as in dreams.

That the excitatory phase of schizophrenia is the induced, and not the inducing, process is evident from the fact that the progress of this disease is in the direction of dullness and stupor.

Accept (positive) induction as the basis of the symptoms of schizophrenia, and you will discern why the patient develops the belief that he is under the influence of some person or power, and why he sometimes imagines that his thoughts are not quite his own thoughts. According to Penfield, those whose exposed brains are touched by electrodes and who, as a consequence, hallucinate or perform automatic acts, feel that those acts and subjective sensory experiences are not quite their own.[8]

The type of the dream-pattern apparently depends upon the depth of sleep wherein the dream is induced. During lighter sleep, the dream is apt to consist of fairly integrated wholes with here and there a fusion of incoherent elements. During deeper sleep, the dream is more apt to consist of a series of psychologically unrelated wisps and shreds which are not integrated into definite wholes. The same is true of the mentation-pattern in schizophrenia. Word-salad expressive of the mental content in the severest form of schizophrenia,

the catatonic, closely corresponds to the fragmentary content of the dream occurring during deeper sleep. Where the schizophrenia is less profound, as in the paranoic form, well integrated large patterns are clearly in evidence.

SUMMARY

To sum up: accept the interpretation that schizophrenia is due to some form of blocking of nerve paths, and you will expect — *what you actually find* — the following:

1. Blocking (dissociation) between the ideational and the affective elements of mental life. This is manifested by the growing indifference which is so often found in schizophrenia.

2. Blocking of some affective substrata, with the result of the stimulation — by induction — of antithetic affective elements. There is a distinct or vague paranoid element in almost all the forms of dementia praecox. The sense of being persecuted implies a state of — induced — fear. Quite often the induced affective state is that depression.

3. Incongruity of the mental elements due to association (by simultaneity) of induced affective states with ideational contents of different or antithetical characteristics: in other words, mis-associations.

4. Hallucinations due to positive induction of stimulation of corresponding substrata.

5. Delusions due, as the above, to the stimulation of areas surrounded by blockades — islands whose contents cannot be integrated with other data under circumstances when normal integration would lead to judicious conclusions. The patient, for instance, may believe that he is a king while knowing (remembering) all the data of his life which are more than sufficient to prove that his grandiose delusion is decidedly absurd. In other words, the patient is unable to put two and two together.

6. Reversals, as observed in negativistic responses, also in reversals of attitude toward the facts of the outer world.

7. Fragmentation — by blocking — of the mental content as is manifested by what is described as word-salad.

8. The belief by the patient that he is under the influence of some person or power, and his feeling that his thoughts are not quite his own thoughts. All these because the stimulation induced by blocking is like the stimulation induced by the electrode applied to the cortex, in which instance the subject feels that he is not the one behind the automatic activities or the sensory or other experiences.

The stimulation of cortical areas may give rise to the revocation of fragments or wholes of bygone events or to the "experience" of events not known before. The same is presumably true of the induced stimulation in schizophrenia. There is the possibility that the long-since-forgotten elements of the remote past are, to an extent at least, in an antithetic relation to the elements of more recent life, so that when there is a complete or partial blocking of the latter there is an induced ascendency of the former. Some of the features of senility are strongly suggestive of such an interrelation.

RESUMEN

Al aceptar la interpretación de que la esquizofrenia se debe al bloqueo de una vía nerviosa, se llega a las siguientes conclusiones, que *en realidad son las que se observan en la práctica:*

1. El bloqueo (disociación) entre los elementos ideacionales y afectivos de la vida mental Esto se manifiesta por la indiferencia creciente que se observa tan frecuentemente en la esquizofrenia.

2. Bloqueo de algunos substratos afectivos, que ocasionan la estimulación — por inducción — de los elementos afectivos antitéticos. En casi todas las formas de demencia precoz hay un elemento paranoide definido o vago. El sentimiento de persecución implica un estado de miedo (inducido). Con frecuencia esta depresión es el estado afectivo inducido.

3. Incongruencia de los elementos mentales debido a la asociación (por simultaneidad) de los estados afectivos inducidos con contenidos ideacionales de características diferentes o antitéticas: en otras palabras, falta de asociación.

4. Alucinaciones debidas a la inducción positiva de estimulación de los substratos correspondientes.

5. Ilusiones ocasionadas, como las anteriores, por la estimulación de áreas rodeadas de bloqueos nerviosos — islotes cuyo contenido no puede ser integrado con otros datos, en condiciones en que la integración normal conduciría a conclusiones sensatas. El paciente, por ejemplo, puede creer que es un rey, al tiempo que sabe (memoria) todo los antecedentes de su vida, que son más que suficientes para demostrar que sus delirios de grandeza son decididamente absurdos. En otros términos, el paciente no sabe cuántos son dos y dos.

6. Reversiones, como las observadas en respuestas negativas o en reversiones de la actitud en presencia de los hechos del mundo exterior.

7. Fragmentación — por bloqueo — del contenido mental, como se manifiesta por lo que se describe como "ensalada-verbal."

8. La creencia del paciente de que está bajo la influencia de alguna persona o de cierto poder, y la sensación de que sus pensamientos no son totalmente suyos. Todo esto porque la estimulación inducida por el bloqueo es similar a la estimulación inducida por un electrodo aplicado a la corteza cerebral, en la que el paciente tiene la sensación de no ser él quien efectúa las actividades automáticas o quien recibe sensaciones u otras experiencias.

La estimulación de las áreas corticales puede originar la revocación de fragmentos o la totalidad de sucesos pasados, o bien producir una sensación de estar viviendo (experimentando) sucesos desconocidos anteriormente. Posiblemente éste también sea el caso de la estimulación inducida en la esquizofrenia. Existe la posibilidad de que los elementos del pasado remoto, olvidados hace mucho tiempo, tengan, al menos hasta cierto punto, una relación antitética con elementos de épocas más recientes de la vida, de modo que cuando éstos están parcial o totalmente bloqueados, se produce una ascendencia inducida de los elementos del pasado. Algunas de las características de la senilidad sugieren tal interrelación.

RESUME

En résumé: si l'on admet l'interprétation que la schizophrénie est due à quelque forme de blocage des circuits nerveux, on sattend à trouver—*et l'on trouve effectivement*—ce qui suit:

1. Un blocage (dissociation) entre les éléments idéationnels et les éléments affectifs de la vie mentale. Ceci se manifeste par l'indifférence croissante qu'on observe si fréquemment dans les cas de schizophrénie.

2. Un blocage de certains substrats affectifs, ce qui se traduit par la stimulation—par induction—d'éléments affectifs antithétiques. Il y a un élément paranoïdique net ou vague dans presque toutes les formes de démence précoce. Le sentiment d'être persécuté suppose un état de crainte—provoquée. Très souvent, l'état affectif provoqué est celui de l'abattement mental.

3. Un désaccord des éléments mentaux par suite de l'association (par simultanéité) d'états affectifs provoqués avec des éléments ideationnels de caractéristiques différentes ou antithétiques: en d'autres termes, des mésassociations.

4. Des hallucinations causées par la provocation positive de la stimulation des substrats correspondants.

5. Des illusions provoquées, comme ci-dessus, par la stimulation des régions entourées de "blocus"—constituant des îlots dont les éléments ne peuvent être intégrés avec d'autres éléments dans des conditions où l'intégration normale aboutirait à des conclusions judicieuses. Le sujet, par exemple, peut s'imaginer qu'il est roi tout en ayant connaissance (se souvenant) de tous les faits de sa vie qui sont amplement suffisants pour lui prouver que son illusion de grandeur est parafaitement absurde. En d'autres termes, le sujet en cause est absolument incapable de rapprocher des faits dans son esprit.

6. Des revirements, qui se traduisent par des réactions négativistiques, ainsi que par des changements d'attitude à l'égard des faits du monde extérieur.

7. Une fragmentation—par blocage—des éléments mentaux, ce qui se manifeste par ce qu'on a appelé une "salade de mots."

8. Le sentiment illusoire qu'entretient le sujet qu'il est sous l'influence de quelque personne ou puissance, et l'impression qu'il ressent que ses pensées ne sont pas tout à fait les siennes. Tout cela est dû à ce que la stimulation provoquée par blocage est analogue à la stimulation provoquée par l'électrode appliquée à la substance corticale, cas dans lequel le sujet a l'impression qu'il n'est pas responsable des activités automatiques, ainsi que des expériences sensorielles ou autres qu'il ressent.

La stimulation des régions corticales est de nature à occasionner la révocation de fragments ou de la totalité d'évènements passés ou à "l'expérience" de faits inconnus jusqu'alors. Les mêmes conclusions s'appliquent censément à la stimulation provoquée dans les cas de schizophrénie. La possibilité existe que les éléments depuis longtemps oubliés du passé lointain soient, dans une certaine mesure au moins, en relation antithétique à l'égard des éléments de la vie plus récente, d'où il s'ensuit que lorsqu'il y a blocage complet ou partiel

de ces derniers, on obtient une prédominance provoquée des premiers. Certains des aspects de sénilité suggèrent fortement l'existence de cette corrélation.

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The Outstanding Personality Factors Among the Population of A State Penitentiary: A Preliminary Report

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Throughout the years many attempts have been made to study the causes of criminal behavior but what has been described and mainly held responsible for the causation of criminal behavior has been, for the most part, the hereditary *anlage* and the physical factors of criminals. It was once thought that the criminal was predestined to his criminal career because of his inherited traits and that he was, therefore, wholly irresponsible. Later, on the basis of the now classical anthropologic investigations of Lombroso,[1] it was thought that there were certain physical anomalies characteristic only to criminals. From that time on, the hypothesis of physical inferiority among criminals was generally accepted. Still, however, especially since Kretschmer's famous works on *Physique and Character*,[2] an attempt was made to establish relationships between body build and criminal behavior, and Aschaffenburg,[3] among others, believed that the pyknic type is more prevalent among occasional offenders, while the asthenic and athletic types are more frequently encountered among habitual offenders. Sauer,[4] on the other hand, recognized that the cyclothyme tended to be directed more toward crimes of violence while the schizothyme tended toward crimes of acquisitiveness. Many studies have appeared, especially in the German and Russian literature, either to confirm or to contradict Sauer's assumption that pyknics commit acts of violence. This theory, however, has not been generally accepted. It was felt that while some degree of correlation between the physical and psychologic constitution can often be traced, transition forms or mixed types where no correlation could be established are also frequently found. In this respect Landecker[5] warned that "the thesis of an association between physique and character should be applied in the field of criminology with extreme caution. There are a variety of other factors which contribute also to the formation of behavior patterns. Science is not yet in a position to determine the share of constitutional factors as compared with others."

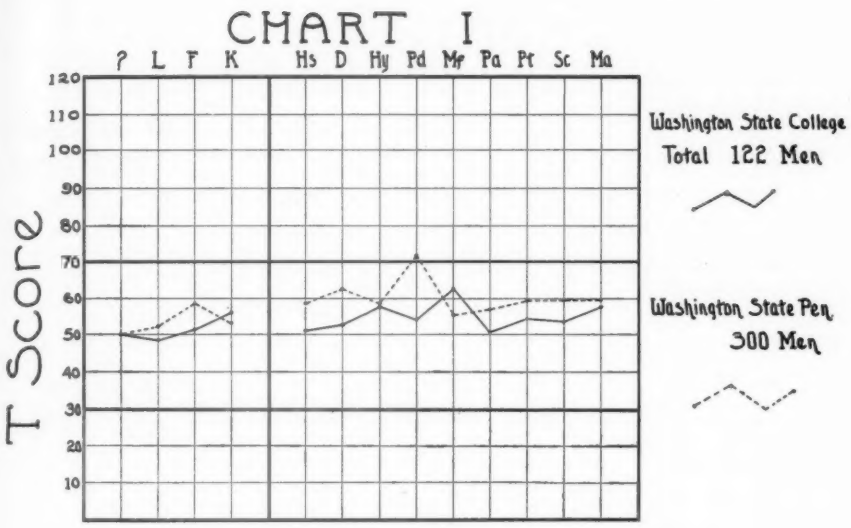
These misconceptions have, in the past, often obscured the facts, and it was said to be rather difficult to decide in individual cases whether the physical or the mental condition of an offender was predominant in causing criminal acts. Sociologic studies, laboratory investi-

This paper was read at the annual meeting of the Medical Correctional Association and the American Prison Association at St. Louis, Missouri, October 9, 1950.

gations, including such indices as the electroencephalogram, and also psychologic examinations have been helpful thus far, and will in the future certainly still further enable us to help society as well as the offender, elucidating the complex physical, mental, and other factors associated with criminal behavior.

More recently, with the advancement of clinical psychology, various psychologic tests have been devised which give a clue to behavior and personality tendencies, and enable the examiner to predict, to a certain degree, the personality development of the individual. These tests, however, have been for the most part applied to so-called normal groups and mentally ill persons, comparatively little study having been devoted to the personality make-up of already established criminals confined to penal institutions. It is true that, from the psychiatric point of view, the criminal is considered either a psychoneurotic or a psychopath, but the specific personality factors that may be common to all criminals have not been elaborated on, so far as we have been able to ascertain.

One of the more recent tests designed to measure personality factors is the Minnesota Multiphasic Personality Inventory (MMPI). This test, easily administered and interpreted, is a psychometric instrument designed ultimately to provide in simple form scores on all the more important phases of personality. In an attempt to assess the various phases of the total personality, groups of statements have been devised to which "true," "false," and "cannot say" responses may be given. The profile consists of various scales including hypochondriasis (Hs), Depression (D), Hysteria (Hy), Psychopathic Deviate (Pd), Masculine and Feminine Interest (sex — MF), Paranoia (Pa), Psychasthenia (Pt), Schizophrenia (Sc), and Hypomania (Ma). In addition, there are question and lie scores which measure the degree to which the subject may be attempting to falsify his score by purposely choosing the responses that place him in the most acceptable light in society. Thus, the question score (?) is a validating score consisting simply of the total number of items put in the "I can't say" category; the size of this score affects the significance of the other scores. The lie score (L) is also a validating score that affords a measure of the degree to which the subject may be attempting to falsify his scores by always choosing the response that places him in the most acceptable light socially. The validity score (F) is more a personality scale which serves as a check on the validity of the whole record. If the (F) score is high the other scales are likely to be invalid, either because the subject was careless, or was unable to comprehend the items. There is also the so-called (K) score, which represents the correctional factor. The cards sorted by the individual into the "true," "false," and "cannot say" categories are tabulated on a simplified record sheet that provides the basic record to be scored by any one of the various keys. The various profile scales, though named according to abnormal manifestations of the symptomatic complex, have been shown to have meaning within the normal range. In the presentation of the results of the test, the usual procedure is to translate the raw score of the measured traits into a standard or (T) score and plot it on a profile chart. This procedure permits analysis of the relative strength of the various phases, the pattern of which is often more important than the presence of any one phase to an abnormal degree. One important fact to remem-



ber in this test is that a standard score of 50 is average, and each 10 points above or below represent one unit of standard deviation from the norm. Standard scores above 70 are definitely considered indicative of serious personality defects.[6]

The present study, based on this test, is an attempt to establish outstanding personality factors among the population of a penal institution, to compare these with a control group of so-called normal, socially well-adjusted individuals, and, if possible, to work out a standard chart which could be used in prison classification and as a prognostic guide for the subsequent extra-institutional social adjustment of the individuals.

MATERIAL AND METHODS

Three hundred consecutive male admissions to the Washington State Penitentiary at Walla Walla, Washington, regardless of age, race, and crime, were tested; for the control group, 122 students of the Washington State College at Pullman, Washington, were used.

The group form of the Minnesota Multiphasic Personality Inventory was given to the 300 inmates of the Washington State Penitentiary. (This was not done until the inmates had been at the penitentiary for at least one month and had made at least a superficial social adjustment to their new environment.) The same form was also used in the control group. The results were plotted on a profile chart, and the average profile was obtained for each group. All statistical errors and deviations were already eliminated when the T score for the individual was calculated, since the T score represents the statistically modified raw score.

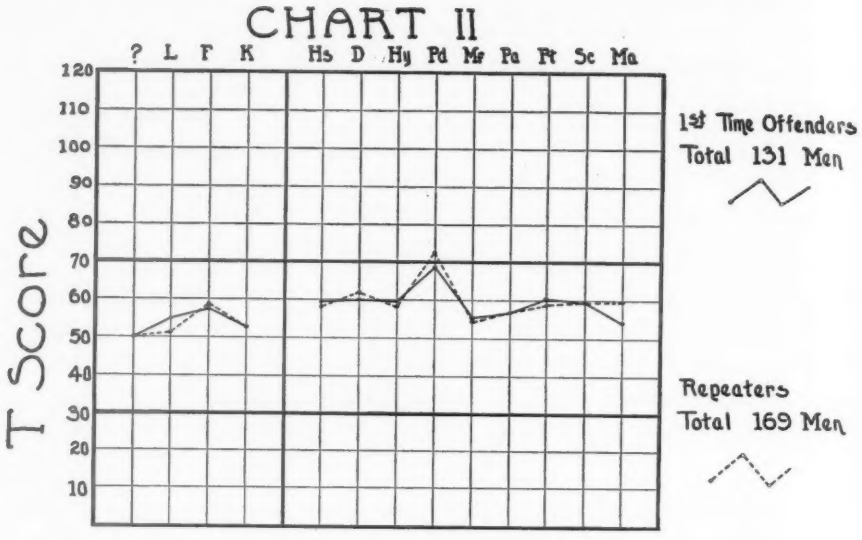


CHART II
? L F K Hs D Hy Pd Mf Pa Pt Sc Ma
120
110
100
90
80
70
60
50
40
30
20
10
T Score
1st Time Offenders
Total 131 Men
Repeaters
Total 169 Men

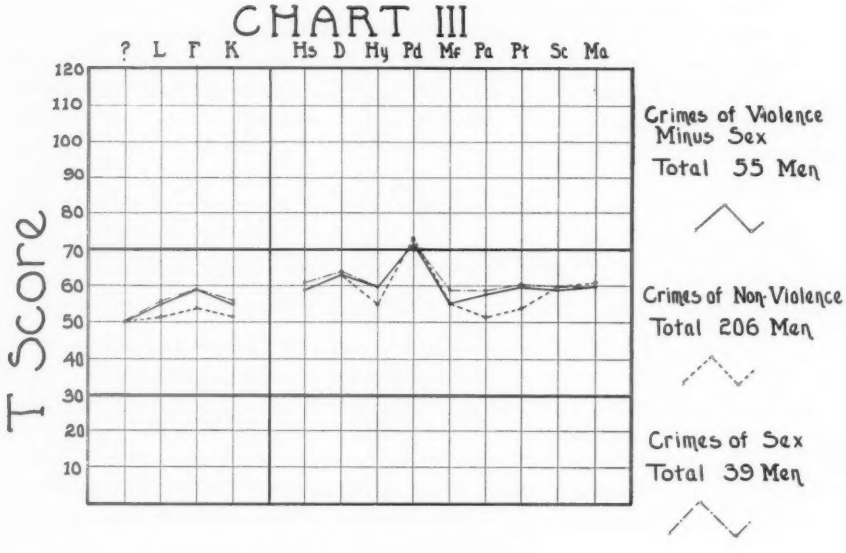
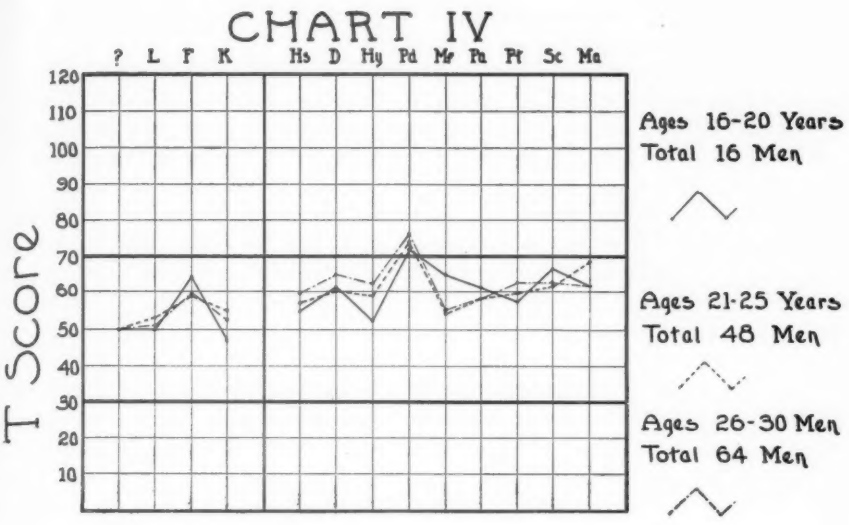


CHART III
? L F K Hs D Hy Pd Mf Pa Pt Sc Ma
120
110
100
90
80
70
60
50
40
30
20
10
T Score
Crimes of Violence
Minus Sex
Total 55 Men
Crimes of Non-Violence
Total 206 Men
Crimes of Sex
Total 39 Men



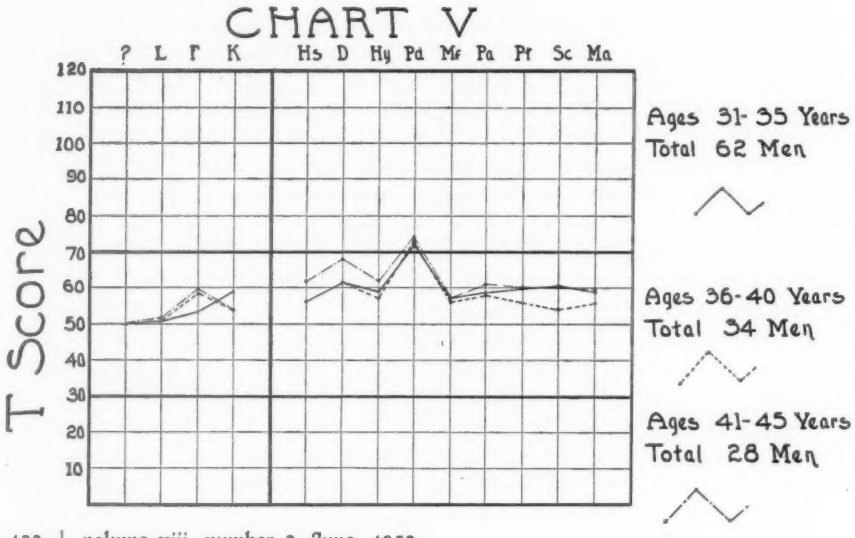
RESULTS

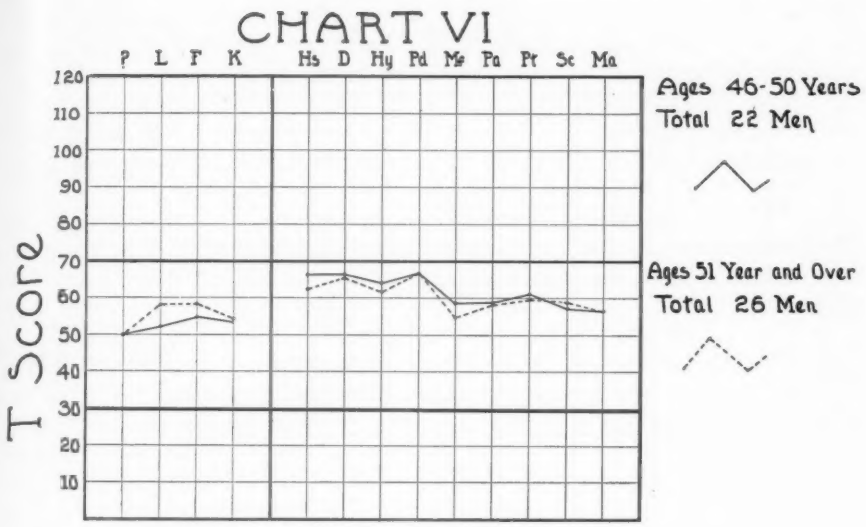
Chart I shows the average profile of the 300 inmates at Washington State Penitentiary, as well as of the control group consisting of 122 students of Washington State College. In comparing these two charts it can be seen that the profile of the criminal group as a rule averages 6 to 10 scores higher than the control group, with the exception of the MF scale, which is approximately 5 T scores higher in the control group. In the criminal group, it is quite obvious that the highest T score was obtained on the Pd scale, definitely indicating serious pathology. The D, or depression scale, is also rather high among the criminal group, although not as marked as the Pd scale. The surprising finding, in interpreting the chart, is that the Mf scale is higher in the control group than in the criminal group, indicating, on the surface, that sexual adjustment appears to be better among criminals than among college students, a fact that will be elaborated on later. It is also interesting to note that the scales which are indicative of psychoneurotic tendencies, such as Hs, Hy, and Pt are either the same in both groups or slightly higher in the criminal group. This is in sharp contrast to the Pd scale, which is markedly higher in the criminal group than in the control group. Certain schools of thought advocate that at least 85 per cent of all the so-called psychopaths are primarily psychoneurotics and that, especially among criminals, the psychoneurotic reaction types are represented in very great numbers. On the basis of this study, at least, it would appear that such a belief is very much open to discussion, since the incidence of psychopathic deviates is extremely high and out of proportion, compared with the control group, while the neurotic scales are at about the same level in both groups. If

the view were justified, one would expect the neurotic scales to be at least as high as, or even higher than, the psychopathic.

Once the criminal group had been compared with the control group, further studies were made within the criminal group. This group was first divided into two sub-groups, chart II representing 131 first offenders and 169 repeaters. The outstanding factor on this chart is the high and definitely abnormal Pd scale in the repeater group. The D factor also seems somewhat higher in the repeater group. Again, the neurotic scale is about the same in both groups. This finding seems to us of great importance, especially in predicting the parole prognosis of the individual who is a first offender. If, on the MMPI, he should show a high and abnormal Pd, then his prognosis for extra-institutional social adjustment does not appear to be too good and it is likely that he will be a repeater. On the other hand, if the Pd scale is within normal limits, his prognosis, at least on the basis of this test, appears to be much better.

The total group of 300 criminals was then divided into three subgroups according to the type of crime involved. The types of crime were divided arbitrarily into crimes where violence was involved, excluding sex crimes (55 offenders), crimes of nonviolence, excluding sex crimes (206 offenders), and finally all crimes of sex (39 offenders), as shown in chart III. This chart revealed a very interesting finding, namely, that the average personality profile of criminals convicted of crimes of violence and those convicted of crimes of sex are very similar, while the average personality profile of persons convicted of nonviolent crimes is rather different from the two above-named groups. This again, in our opinion, has practical implications, since it indicates that any person convicted of a sex crime is potentially a person likely to commit a crime of violence.





The group was then divided according to age at the time of admission to the Washington State Penitentiary, regardless of the type of crime and number of convictions. Chart IV comprises 16 men between the ages of 16 and 20 years, 48 men between the ages of 21 and 25 years, and 64 men between the ages of 26 and 30 years. Chart V shows 62 men between the ages of 31 and 35 years, 34 men between the ages of 36 and 40, and 28 men between the ages of 41 and 45 years. Chart VI comprises 22 men between the ages of 46 and 50 years and 26 men, 51 years of age and older. In comparing these charts, it will be seen that the psychopathic scale reaches its peak at the ages of 26 and 30 years and then gradually declines until it is within the normal range from 45 years on. The neurotic scales, although still within the normal range, are highest during the middle age group, while the depression scale rises from the age of 40 years on but still remains within relatively normal range. On the other hand, the sex scale is higher during the youngest age group, as is the schizophrenia scale, while in the other age groups, the two scales are within normal range. These findings are very interesting. They show that with advancing age prisoners are somewhat inclined to develop neurotic and depressive signs, especially during middle age, which, on the other hand, might be indicative of the male climacterium. Furthermore, they show that since the psychopathic scale reaches its climax during the ages from 26 to 30 years and then declines, more crimes are apt to be committed by people within this age group. Further proof for this is found in the fact that the average age of inmates at this penitentiary is approximately 27 years.

The finding that the Mf scale (sex) is high in the younger age group would at least

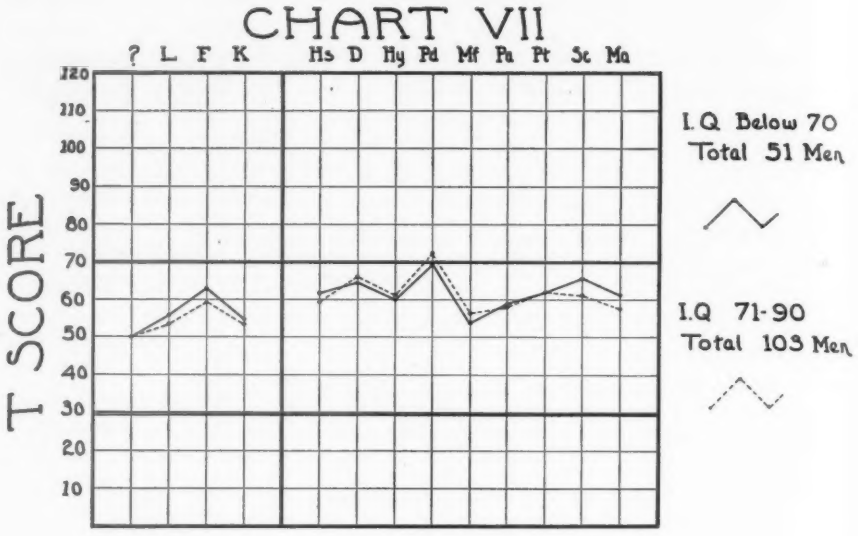


CHART VII
? L F K Hs D Hy Pd Mf Pa Pt Sc Ma
T SCORE
120
110
100
90
80
70
60
50
40
30
20
10
I.Q. Below 70
Total 51 Men
I.Q. 71-90
Total 103 Men

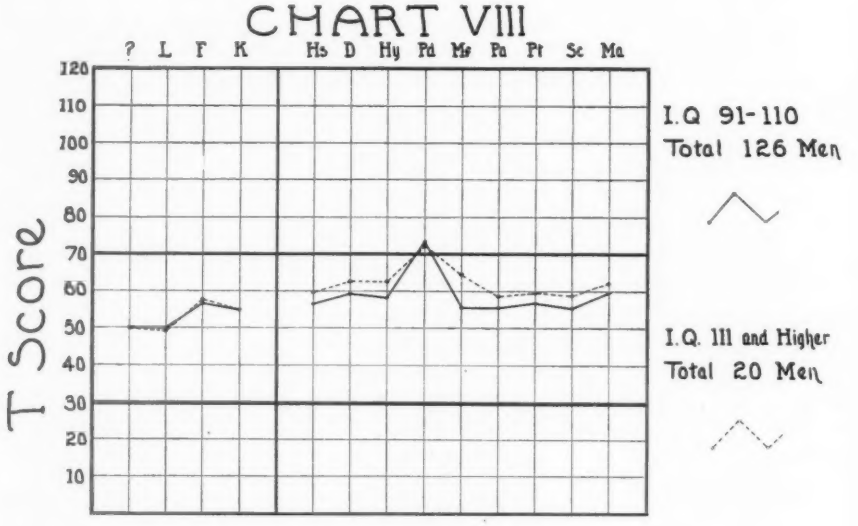
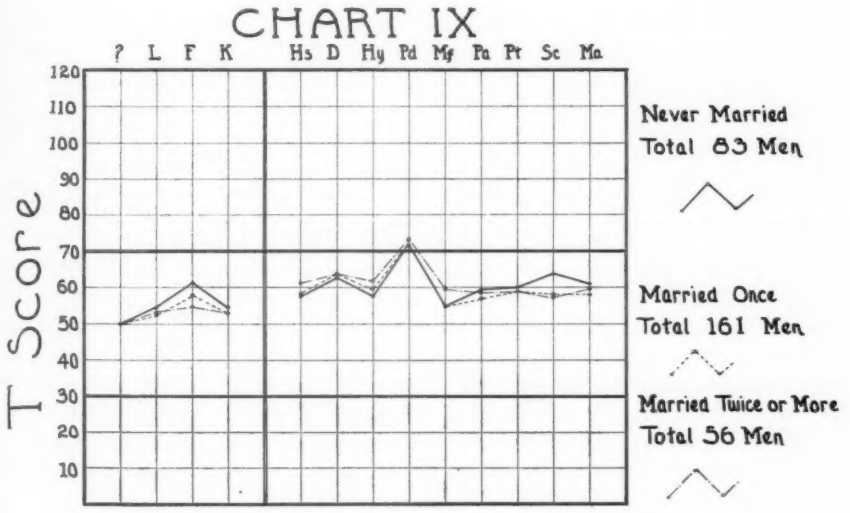


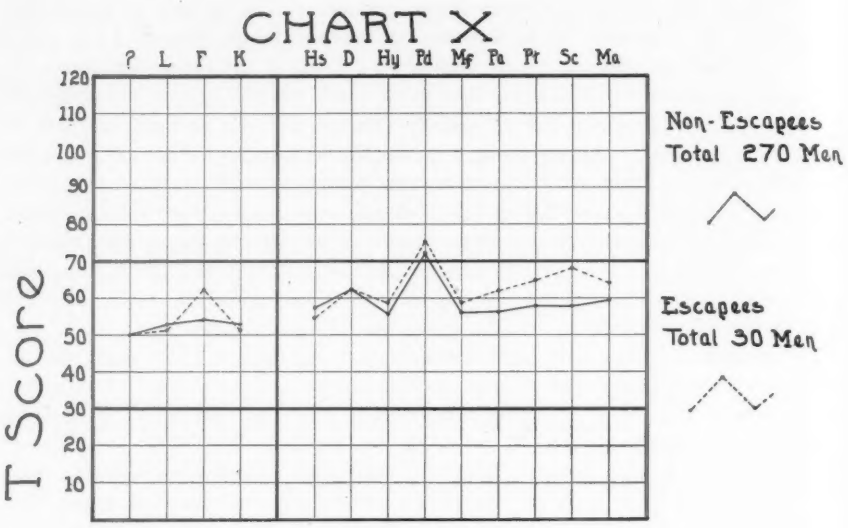
CHART VIII
? L F K Hs D Hy Pd Ms Pa Pt Sc Ma
T Score
120
110
100
90
80
70
60
50
40
30
20
10
I.Q. 91-110
Total 126 Men
I.Q. 111 and Higher
Total 20 Men

partly indicate that sexual maladjustment does not appear to be entirely on an environmental basis, but is possibly due to endocrinologic and physiologic changes of late adolescence. In this connection one should recall chart I, where it was shown that within the college group the Mf scale was higher than in the entire criminal group. The average Mf scale on this chart is almost identical with the average Mf scale obtained on chart IV (ages 16 to 20), which is not surprising, if one recalls the fact that the average age of the college student is approximately 20 years, as is the average age of the offenders comprising this graph line. It again proves that sexual maladjustment is probably due to this particular age period with its characteristic physiologic changes rather than primarily to environmental influences. Finally, it is of interest to note that, as would be expected, the schizophrenic scale is the highest among the 16 to 20 year olds, which is in conformity with present-day thinking that schizophrenia is a disorder originating during adolescence.

The criminal group was then classified according to I.Q. obtained on standard tests regardless of chronologic age, types of crime, and number of convictions. Chart VII comprises 51 men with an I.Q. below 70 (mental deficiency) and 103 men with an I.Q. of 71 to 90 (borderline intelligence). Chart VIII shows 126 men with an I.Q. of 90 to 110 (average intelligence) and 20 men with an I.Q. of 111 and higher (superior intelligence). From these charts it will be seen that the Pd scale is the lowest in the lowest I.Q. group. This would tend to indicate that behavior difficulties in persons with low I.Q. are due primarily to their mental deficiency rather than to psychopathic characteristics. The Mf scale, on the other hand, deviates more from the norm within the high I.Q. group.

The offenders were then arbitrarily divided according to marital status, regardless of





ages, type of crime, and number of convictions, into the following groups: never married, 83; persons married once (including those divorced, widowed but never remarried), 161; married twice and more, 56 (chart IX). In analyzing this chart, it will be seen that the neurotic scales such as hysteria and hypochondriasis, as well as the sex scale, are higher among those who have married twice or more. That sex adjustment among these persons is not so good as among those who have been married only once is quite obvious, since this factor is, in many cases, responsible for the break-up of the marriage. The higher score on the neurotic scales, on the other hand, seemed also indicative of an etiological factor in the break-up of the marriages. Furthermore, it is of interest to note that the schizophrenic scale is highest in the single group, confirming the belief that the incidence of mental illness is greater in single persons than in married people.

Finally, the total group was divided into offenders without escape records, consisting of 270 men, and those with escape records, consisting of 30 men (chart X). The results definitely show that the paranoid scale, the schizophrenic scale, and the hypomania scale have higher representation among the escapees, which might tend to indicate that some of the escapes are based on projective mechanisms and that among the goals of the escapee may be the desire to get even with society. On the other hand, on the basis of the high Ma scale, it would also show that the escapee tends to be more restless and hyperactive and thus is unable to settle down in any environment, and this, in turn, might be a basic cause for escape.

SUMMARY AND CONCLUSION

On the basis of this study, several definite conclusions can be drawn which appear to us to have extremely practical implications for arranging a proper prison classification, as well as for planning and making proper parole prognoses. Although we are aware of the difficulty of obtaining sample data representing the universe of criminals, and of the fact that offenders in custody are not necessarily representative of all criminals while a sample of the general population is likely to include a proportion of undetected as well as future offenders, the test group, as well as the control group, seems to us large enough, and the findings so definite, that the following conclusions seem justifiable.

This study shows that we are probably dealing among criminals with a group consisting primarily of psychopaths and not neurotics or psychotics.

It reveals further that repeaters have a higher psychopathic deviate score than first offenders, and the conclusion seems inevitable that the higher the psychopathic scale in a first offender, the greater the likelihood that he will become a repeater.

It reveals that the psychopathic deviate scale has its climax within the age group from 26 to 30 years and then gradually declines, indicating, for all practical purposes, that more crimes are committed by persons in this age group than in any other, a fact that is further confirmed by the average age of prisoners at this institution, which falls within this age group.

It shows that the personality (factors) in persons who commit crimes of violence and in those who commit crimes involving sex are almost identical and entirely different from the personality factors of persons committing nonviolent crimes. This finding, translated, would indicate that persons convicted of sex crimes are potentially persons likely to commit crimes of violence.

It shows that convicts are inclined to develop neurotic and depressive features, especially during the middle age period, a fact which to us appears to be important enough to be brought to the attention of prison personnel, especially the medical personnel.

It shows, further, that sexual maladjustment is highest in the youngest age group, which would tend to indicate that it is primarily due to the physiologic changes of late adolescence rather than to environment.

It shows that within the group of mental defectives the psychopathic scale is low, indicating that their antisocial behavior is based primarily on intellectual retardation rather than psychopathic personality traits and that this type of person is, because of his low intellect, extremely easily influenced by others, made a tool of others, taken advantage of, and, in general, should be considered a follower, rather than a leader, in antisocial activities.

It shows that multiple marriages are probably caused by a combination of sexual maladjustment and neurotic personality trends.

And, finally, it reveals that the escapee has an entirely different personality profile than the nonescapee. The escapee seemed inclined to project more than others (as evidenced by the high Pa and Sc scale), and this could be used, practically, for probable escape

predictions. However, since the escapee has also a high Ma scale, it might also be indicative of inner restlessness, hyperactivity, and inability to settle down in any environment, which, in turn, might be the causative factor for his trying to escape.

RESUMEN

Teniendo como base este estudio, se pueden sacar conclusiones precisas que tienen implicaciones extraordinariamente prácticas en cuanto a la clasificación en las prisiones, lo mismo que en la concesión y prognosis de la libertad bajo palabra. Aunque es muy difícil obtener casos típicos que representen el mundo (universo) de los criminales, y el hecho de que los reos bajo custodia no representan necesariamente el tipo de todos los criminales, ya que un grupo de la población en general puede incluir cierta proporción de individuos que no han sido descubiertos y también otros que pueden ser futuros criminales, tanto el grupo estudiado como el grupo testigo son lo suficientemente numerosos, y los hallazgos tan definidos, que justifican el sacar las siguientes conclusiones:

Este estudio demuestra que los criminales constituyen un grupo compuesto principalmente por psicópatas y no por neuróticos o psicóticos.

Además pone en claro que los individuos que recaen en ofensas criminales, tienen un grado mayor de desviación psicopática que los infractores que violan la ley por primera vez, lo cual inevitablemente lleva a la conclusión de que la probabilidad de que estos últimos cometan nuevos actos criminales, depende de un mayor grado de desviación psicopática.

Este estudio revela también que la escala de desviación psicopática llega a un punto máximo en el grupo de individuos comprendidos entre los 26 y 30 años de edad y luego decrece gradualmente, indicando, para todos los fines prácticos, que la mayoría de los crímenes son cometidos por individuos de este grupo. Este hecho se comprueba además por el promedio de la edad de los prisioneros en esta institución, que está dentro de los límites anotados.

Se demuestra también que la personalidad (factores) de los individuos que cometen crimenes violentos o de aquéllos que cometen crimenes sexuales es casi idéntica y totalmente distinta de los factores de personalidad de las personas que cometen crímenes no violentos. La interpretación de este hecho indicaría que las personas que han sido condenadas por ofensas sexuales son individuos que potencialmente pueden cometer crímenes violentos.

Asimismo se llega a la conclusión de que los reos son propensos a desarrollar características neuroticas y depresivas, especialmente los convictos de edad madura. Este hecho nos parece lo suficientemente importante para ser tenido en cuenta por el personal administrativo de las prisiones, especialmente de los servicios médicos.

Otro punto que se demuestra, es que las desadaptaciones sexuales son mayores en los grupos jóvenes, lo cual parece indicar que se deben a los cambios fisiológicos del término de la adolescencia más que al medio ambiente.

Se pone en claro asimismo que en el grupo de anormales mentales la escala psicopática es baja, lo cual indica que su proceder antisocial está basado principalmente en un retardo intelectual y no en una personalidad psicopática, y que por su escasa inteligencia, este tipo de individuos es fácil de ser influenciado por otros, transformándolo en instrumento de su voluntad y abusando de él. En general debe ser considerado como subalterno y no como dirigente en materia de actividades antisociales.

Se demuestra que los matrimonios múltiples se deben probablemente a una combinación de desadaptaciones sexuales y de tendencias neuróticas.

Finalmente, se revela que el escapista tiene una personalidad diferente del que no los es. El primero parece estar inclinado a proyectarse más que los demás (como se aprecia por los altos valores en las escalas Pa y Sc) y pudiera ser usado prácticamente para predecir las posibles fugas.

Sin embargo, como el escapista tiene también una escala Ma elevada, es posible que esto indique desasosiego interior, hiperactividad e incapacidad de adaptarse a ningún medio ambiente, que a su vez pudiera ser el factor responsable de su deseo de fuga.

RESUME

Sur la base de la présente étude, il est possible de tirer plusieurs conclusions précises qui nous semblent avoir des implications extrêmement pratiques pour dresser un classement rationnel des prisonniers, ainsi que pour établir les prévisions et les pronostics appropriés concernant les libérations conditionnelles sur parole. Bien que nous nous rendions compte de la difficulté de recueillir des données-types représentant l'ensemble des criminels, et du fait que les délinquants en prison ne constituent pas nécessairement un groupe répresentatif de la totalité des criminels, alors qu'un groupe-spécimen de l'ensemble de la population aurait des chances de comprendre une proportion de délinquants inobservés, ainsi que de délinquants futurs, il n'en est pas moins vrai que le groupe d'essai, de même que le groupe-témoin, nous paraissent assez importants, et les observations si nettes, que les conclusions suivantes nous paraissent parfaitement justifiées.

Cette étude montre que, parmi les criminels, nous sommes probablement en présence d'un groupe composé surtout de psychopathes, et non de névrosés ou de cas psychotiques.

Elle révèle, en outre, que les récidivistes enregistrent une déviation psychopathique plus marquée que les délinquants primaires, et l'on doit nécessairement en conclure que plus l'échelle psychopathique est élevée chez un délinquant primaire, plus la probabilité est grande qu'il deviendra un récidiviste.

Cette etude fait ressortir que l'échelle de déviation psychopathique a son point culminant dans la catégorie d'âge comprise entre 26 et 30 ans, et diminue ensuite graduellement, ce qui indique, à toutes fins pratiques, que davantage de crimes sont commis dans cette catégorie d'âge que tout autre, fait qui est d'ailleurs confirmé par l'âge moyen des prisonniers de la prison en question, qui est comprise dans cette catégorie d'âge.

On voit que les caractéristiques (facteurs) psychiques des personnes qui commettent des

crimes de violence et celles qui commettent des crimes de nature sexuelle sont presque identiques, alors qu'elles diffèrent totalement des facteurs psychiques des individus qui commettent des crimes sans violence. Si l'on interprète cette constatation, on doit en conclure que les individus condamnés pour des crimes sexuels sont potentiellement des personnes qui risquent de commetre des crimes de violence.

L'étude met en lumière que les prisonniers ont tendance à contracter des caractéristiques neurotiques et d'abattement, en particulier pendant la période entre deux âges, fait qui nous semble d'une assez grande importance pour qu'on le signale à l'attention du personnel des prisons, plus particulièrement le personnel médical.

Il ressort encore de cette étude que le déséquilibre sexuel est plus marqué pour le groupe des jeunes prisonniers, ce qui semblerait indiquer que cela est dû surtout aux changements physiologiques qui accompagnent la phase finale de l'adolescence, plutôt qu'au milieu.

Cette étude indique que, parmi le groupe des déficients, l'échelle psychopathique est faible, ce qui montre que leur comportement antisocial est basé surtout sur le développement mental retardé plutôt que sur des traits psychopathiques de la personne, et que ce genre d'individu, à cause de son faible intellectualisme, se laisse extrêmement facilement influencer par d'autres, est à leur merci, se laisse exploiter, et, d'une manière générale, doit être considéré comme un imitateur, plutôt qu'un instigateur, dans les activités antisociales.

Il ressort aussi de cette étude que les mariages multiples sont probablement le résultat d'une combinaison de déséquilibre sexuel et de tendances neurotiques de la personne.

Finalement, l'étude met en lumière le fait qu'un évadé a un type psychopathique totalement différent de celui d'un non-évadé. L'évadé a paru enclin à faire plus fréquemment des projets que les autres (ainsi qu'il ressort de l'échelle élevée du Pa et du Sc), et l'on pourrait tirer un parti pratique de ce renseignement pour les prévisions d'évasion. Toutefois, comme l'évadé a aussi une échelle Ma élevée cela, pourrait aussi être une indication d'agitation intérieure, d'hyperactivité, et d'inaptitude à s'adapter à n'importe quel milieu, ce qui pourrait, par contre-coup, devenir le facteur causatif l'incitant à chercher à s'évader.

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As I Remember Him

Santiago Ramón y Cajal

(1852-1934)

Félix Martí Ibáñez, M.D.

I remember seeing him often in the early nineteen-thirties, a pale, silver bearded, pensive old man, slowly crossing the cool green shades of the patios at the Medical School of San Carlos in Madrid. On this occasion of the centennial of his birth, I want to recall Santiago Ramón y Cajal.

Thanks to him, Spain, which had slowly declined to a state of scientific indigence in sad contrast with the Golden Age of Spanish Medicine of the XVth and XVIth centuries, again joined the vanguard of medical progress. Gimbernat in the XVIIth century, and Casal in the XVIIIth century, partly redeemed Spain from her scientific sterility; but it was Cajal who put her back in the scientific hall of fame.

Cajal was born to the gloomy untamed earth of a dusty village in the province of Navarra, on May 1, 1852. His father was a rural doctor. An indifferent, even poor student, Cajal gave up school to work as apprentice first to a barber and then to a shoemaker. "Reforming," he resumed his studies and gravitated to medicine. Cajal began his career as a physician, became interested in anatomy, then histology, and finally focused upon the study of nerve tissues. His efforts won for him the post of Professor of Anatomy, and later of Histology, in Saragossa, Valencia (1885), Barcelona (1887), and Madrid (1892).*

Cajal's work, after half a century, is still a source of true knowledge. When we review today those works on pathology, therapeutics, and psychiatry which fifty years ago—when Cajal was first beginning—were the medical bibles revered by the doctors of the time, we are amazed at the great number of facts then considered solidly established and which today we regard ironically, unless we keep in mind their importance as forerunners of modern scientific truth. But Cajal's works last; their basic structures are still valid today, and his discoveries in the field of neuronal anatomo-physiology are constantly re-confirmed

*Cajal published over four hundred scientific works and innumerable literary works, ranging from short stories to philosophical treatises. By the end of his life, in addition to the Nobel Prize, he had accumulated over 200 decorations and over 100 academic titles from all over the world. He was appointed member of more than 20 academies and scientific societies, and made doctor *honoris causa* of the Universities of Cambridge, Wurzburg, Clark, Stockholm, Louvain, Barcelona, Strasbourg, Guatemala, Vienna, Philadelphia, Paris, Santiago de Chile, Munich, Coimbra, México, Cadiz, Valladolid, Turin, and New York. He was also honorary member of the Physchiatrie und Nerverkrankeiten Society of Berlin, the Philosophical Society of Philadelphia, the Reale Instituto Lombardo de Science e Lettere of Rome, the American Neurological Society, the Neurological Society of Philadelphia, the Coninbricensis Institut Societas of Coimbra, the Royal Irish Academy of Dublin, the Academia Scientiarum Ulisiponensis, the Neurological Society of Kazan in Russia, the Academia Regia Scientiarum Neerlandica, the Academia Regia Scientiarum Suecica, and many others.

Santiago Ramon y Cajal
(1852-1934)

by new advances in neurology and psychiatry. Experimental thought in medicine will always have the supreme advantage over discursive and dogmatic thought, since it is based on facts and not speculations. Cajal refused to accept the dogmatic authority of the classics which he replaced with observation and experimentation. That is why the luster of youth still clings to his work.

Cajal was a poor man. His only capital was ideas. Unable to find channels through which to make known his discoveries, Cajal decided to create his own journal, the quarterly *Revista trimestral de Histologia normal y patológica,* which, when it first appeared in 1888, was entirely written and illustrated by himself. He could publish only 60 copies per issue, which he sent to scientists in other countries, perhaps because nobody is a prophet in his own land. With a monthly salary of 260 pesetas (about $12 at that time), plus a small income derived from some private teaching, he managed to support his family, his journal, and his research laboratory; in addition, he created a school and made an outstanding place for himself in the fields of philosophy and literature! But his *Revista* did not secure him the recognition he deserved. Only when Cajal was made a member of the Anatomical Society of Germany, whose Berlin convention he attended, did he start the climb to immortality.

Cajal established the anatomical individuality of the neuron and promulgated the neuron doctrine. He described for the first time the true relation of the nerve fiber to the nerve cell, illustrating it with his description of basket structures about the Purkinje cells. His technics enabled definition of isolated nerve elements in detail, their ramifications, arborizations, fibril nets, and synapses. His work neatly rounded out the anatomical arch running from the impression-receiving organ to the effect-producing organ. His chromosilver and reduced silver nitrate staining methods made him a true miniaturist of the nervous system, a water-colorist of the neurons. Not content with lighting up the night of the nervous system, he colored its component parts with his dyes and engraved its cells into the history of medicine. In 1906, he was awarded the well-merited Nobel Prize in conjunction with Golgi. The anatomical discoveries of Vesalius and his followers were succeeded in the history of medicine by the physiological discoveries of Harvey and his successors. Cajal, however, was able to succeed *himself* and to proceed from his morphological preoccupation with the "what" of the nervous system, to ascertaining the "why" of its physiologic functions. His contributions to the knowledge of neuroanatomy stand as the permanent basis for our present-day conceptions in neurology and psychiatry. He belongs with His and Forel, Nissl and Weigert, Alzheimer and Bielschowsky, Vogts, Spielmeyer, and Jakob. His chapter on the doctrine of the neuron in the *Handbuch der Neurologie* of Bumke and Foerster (published posthumously as a sort of scientific last will-and-testament) was eulogized by Bielschowsky: "in ihrer Art bewunderungswurdige" (a marvel). In that essay he objectively demonstrated his doctrine of neuronism, which was the supreme historical rectification of the Galenic doctrine of a morphologic-functional continuity in the nervous tissues. He also added the conclusive proof to the cell doctrine of Schleiden, Schwann, and Virchow when he demonstrated the anatomic, genetic, functional, and trophic

unity of the neuron, along with unity of pathologic reaction and the polarization of nervous stimulation.

Adolf Meyer, commenting on Cajal's lectures on his investigations into the visual and other regions of the cortex, said: "The very remarkable accuracy of description and the sober, critical presentation, free from hypothetical flights, displayed principles of work which unfortunately are abandoned by too many today; it was not an attempt to prove a preconceived hypothesis, but aimed primarily at the accumulation of data. That patient and steady work will, as it has in the past, lead to more valuable results than a mere elaboration of ideas is strongly proved by the entire history of Cajal's career. It is only fair to say that Ramón y Cajal was the greatest champion of neurology that Spain has ever produced. No one discovered and demonstrated more well-defined details in confirmation of the views of Forel and His than this indefatigable Madrid histologist. He did what neither His nor Forel did conclusively: demonstrate the blind arborizations or end-brushes of so many kinds of nerve fibers and the connection of the latter with cell bodies in the cerebellum, the medulla, olfactory bulb, retina, optic centers, the great sympathetic, the cerebral cortex, that the concept and the detailed data in its support are established beyond doubt.

"Cajal demonstrated that: (1) There is no substantial continuity between the processes of different nerve cells. The nerve elements represent cell units, for which he accepts Waldeyer's term "neuron." (2) The protoplasmic processes are those parts of a neuron with which the arborizations of other neurons most likely come in contact and that the contact with the cell body itself is exceptional, being found only in those cells where there are no protoplasmic processes (spinal ganglion, retina). (3) The spreading of received impulses is cellulipetal in the protoplasmic processes and centrifugal in the axis cylinder (law of dynamic polarization).

"In his work, Cajal maintained three *laws* he himself established: (1) The law of economy of time. In the spinal ganglia the cells are attached to the fibers so as to form a T. The conductors are thereby placed in the very axis of the ganglion and in the direction of the shortest way between periphery and posterior root; and the current need not pass through the eccentric cell. (2) The law of economy of matter. In the midbrain of fish, batrachians, reptiles, and birds, there are certain fusiform cells, the axon of which originates from a dendrite. In this way the axon spares the whole distance between the *cell body* and the point of the dendrite from which it originates. (3) The law of economy of space. The body is occasionally placed in regions poor in dendrites of final arborizations of axons: for instance, Dogiel's cells of the internal granular layers of the cortex. The cell body presents the convergence of the protoplasmic expansion towards the origin of the axon, enlarged by the presence of the nucleus."

Cajal's popularity is an interesting historic phenomenon. In Spain, during his lifetime, "Don Santiago" had already become a legendary figure, and when he died, his myth continued. The fame of this man, who was as modest as he was humble, rests on his way of life. His entire existence was made up of study and research at the university and long nights of work at his home until he would fall asleep from sheer exhaustion. All those

who knew how Cajal lived, admired this learned and good man, who had a goal in life and never swerved from the path he had chosen. Even when famous at home and abroad, he had no wish to be minister or ambassador; he would not occupy any public post. Like Pindar, Cajal wished only "to become what he was." This consecrated authenticity of Cajal's life, this fidelity to himself, is the secret of his legend.

Cajal's vocation derived from romantic inclinations of his boyhood when he wanted to be a painter. Psychologically, Cajal was a visual type. His thought was of chromatic texture, that stimulated his interest in coloring the pale gray structures of the nervous system. His work is written with the pen of a man who has a painter's eye, the mind of a colorist, and the soul of a romantic. His early frustrated desires to be an explorer of unknown lands prompted him to explore the human brain. But he was not satisfied with examining the brain under the microscope, he also wished to scrutinize its most recondite structures. Psychologically, he was sublimating his desires to explore the earth's jungles (this explains the romantic vegetable terminology he always used when describing the structures of nerve centers) by exploring the anatomical jungles of the nervous system.

Cajal was a great teacher. For him the university was not simply a means of obtaining a diploma, whose yellow creases years later hide the lost illusions of an ambitious student. For him the university was a true *civitas hipocratica*, where technique must be subordinated to thought. On his lecture platform he dedicated his brilliance to clarity and to lucidity. Cajal created a school of Spanish histology which has extended into the work of his disciples, many of whom would do their most important work in exile. After he died, his contribution — which during his lifetime had been extolled by the masters of medicine all over the world and by philosophers like Bergson — was continued in the physiology of Pavlov and Sherrington.

Gregorio Marañón, in his speech on Cajal before the Royal Academy of Medicine in Spain (1950), said "We are conscious of the abyss which separates a book on neurology written prior to 1880 and one written today; the contrast between a treatise on psychiatry published in the last decades of the nineteenth century and one published today is even greater. The progress which has been made is due in great part to Cajal. Cajal, Sherrington, and Pavlov are the three men who have done most to provide a rational explanation for the mystery of the nervous system." Cajal, like Sherrington, was a philosopher of the nervous system who did his research with the brain of a scientist and the pen of a poet.

Ehrlich once said that the three fundamental requisites of a scientist were *Geld, Geduld,* and *Geschick* (money, patience, and luck). That was not the case with Cajal, who always worked in humble attics and basement laboratories. He had instead the three qualities that Pavlov enjoined upon the young people of his country who wanted to devote themselves to science "First, *consistency*. Study, compare and accumulate facts. No matter how perfect a bird's wing, it could never raise the bird aloft if it were not supported by air. Facts are the air of the scientist. Second, *modesty*. Never think that you know everything. Third, *passion*. Remember, science requires your whole life. Even if you had two lives to give, it would still not be enough. Science demands of man effort and supreme passion. Be passionate in your work and in your quests." All that was Cajal.

RESUMEN

El autor que ha tenido el privilegio de conocer y haber escuchado al ilustre Santiago Ramón y Cajal, aprovecha la ocasión de cumplirse el centenario de su nacimiento para dar a conocer algunos rasgos de la vida del sabio doctor. Cajal que dedicó 60 años de su vida a la ciencia, se concentró en el estudio de los tejidos nerviosos y sus descubrimientos en el terreno de la anatomofisiología neuronal son constantemente reconocidos como otros tantos aciertos con motivo de los nuevos avances en neurología y psiquiatría. El sabio español estableció la individualidad anatómica de la neurona, promulgando al mismo tiempo la doctrina neuronal. Las contribuciones de Cajal al conocimiento de la neuroanatomía constituyen las bases permanentes para establecer en la actualidad nuestras concepciones sobre neurología y psiquiatría. Así se explica que Cajal sea uno de los hombres de ciencia que más nombre ha dado a España y haga figurar a su patria en los heraldos de la fama científica.

Ramón y Cajal ha publicado más de cuatrocientos trabajos científicos e innumerables trozos literarios, desde novelas cortas a tratados filosóficos. En los últimos años de su vida, además del Premio Nobel ha recibido más de 200 condecoraciones y más de 100 títulos académicos procedentes de todas las partes del mundo.

Durante su vida el sabio español se convirtió en una verdadera figura legendaria. La fama de su nombre descansa en su género de vida, tan modesta como humilde. Su vida entera fué dedicada al estudio y la experimentación. Todos los que conocieron a Ramón y Cajal admiraron su tenacidad y resolución en la conquista de la verdad que perseguía.

RÉSUMÉ

A l'occasion du centenaire de la naissance de Santiago Raymón y Cajal, l'auteur, qui a eu le privilège de le connaître et de l'entendre, s'est donné pour tâche de retracer la vie de Cajal. Cajal, qui a consacré six décades de sa vie à la science, s'est concentré sur l'étude des tissus nerveux, et ses découvertes dans le domaine de l'anatomo-physiologie des nerfs trouvent constamment une confirmation nouvelle dans les plus récents progrès de la neurologie et de la psychiatrie. C'est lui qui a démontré le caractère anatomique individuel du neuron ou cellule nerveuse, et qui a proclamé la doctrine neuronique. Les contributions de Cajal dans le domaine de la neuro-anatomie constituent la base permanente de nos conceptions actuelles en neurologie et en psychiatrie. C'est à Cajal que l'Espagne doit d'avoir repris rang parmi les noms illustres dans le Temple de Mémoire de la science.

Cajal a publié plus de quatre cents ouvrages scientifiques et d'innombrables ouvrages littéraires, allant de simples contes à des traités philosophiques. Vers la fin de sa vie, outre le Prix Nobel, il avait reçu plus de 200 décorations et plus de 100 titres académiques provenant de multiples pays.

De son vivant, Cajal était devenu un véritable personnage légendaire. Le renom de ce savant, qui était aussi modeste qu'il était humble, tient à sa manière de vivre. Son existence toute entière a été faite d'études et de recherches. Tous ceux qui ont connu Cajal dans son mode de vie n'ont pu que vénérer cet érudit vertueux qui avait un but bien arrêté dans la vie et qui ne s'est jamais écarté du chemin qu'il s'était tracé.